Regional Information Report 4K08-12

Documentation of Marine Stewardship Council conditions for the Chignik Area Salmon Fishery

by

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and

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December 2008

Alaska Department of Fish and Game Divisions of Sport Fish and Commercial Fisheries

Symbols and Abbreviations

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Weights and measures (metric)

centimeter	cm
deciliter	dL
gram	g
hectare	ha
kilogram	kg
kilometer	km
liter	L
meter	m
milliliter	mL
millimeter	mm

Weights and measures (English)

cubic feet per second	ft^3/s
foot	ft
gallon	gal
inch	in
mile	mi
nautical mile	nmi
ounce	oz
pound	lb
quart	qt
yard	yd

Time and temperature

day	d
degrees Celsius	°C
degrees Fahrenheit	°F
degrees kelvin	K
hour	h
minute	min
second	s

Physics and chemistry

all atomic symbols	
alternating current	AC
ampere	A
calorie	cal
direct current	DC
hertz	Hz
horsepower	hp
hydrogen ion activity (negative log of)	pH
parts per million	ppm
parts per thousand	ppt, ‰
volts	V
watts	W

General

Alaska Administrative Code	AAC
all commonly accepted abbreviations	e.g., Mr., Mrs., AM, PM, etc.
all commonly accepted professional titles	e.g., Dr., Ph.D., R.N., etc.
at	@
compass directions:	
east	E
north	N
south	S
west	W
copyright	©
corporate suffixes:	
Company	Co.
Corporation	Corp.
Incorporated	Inc.
Limited	Ltd.
District of Columbia	D.C.
et alii (and others)	et al.
et cetera (and so forth)	etc.
exempli gratia (for example)	e.g.
Federal Information Code	FIC
id est (that is)	i.e.
latitude or longitude	lat. or long.
monetary symbols (U.S.)	\$, ¢
months (tables and figures): first three letters	Jan,...,Dec
registered trademark	®
trademark	™
United States (adjective)	U.S.
United States of America (noun)	USA
U.S.C.	United States Code
U.S. state	use two-letter abbreviations (e.g., AK, WA)

Measures (fisheries)

fork length	FL
mideye to fork	MEF
mideye to tail fork	METF
standard length	SL
total length	TL

Mathematics, statistics

all standard mathematical signs, symbols and abbreviations	
alternate hypothesis	H_A
base of natural logarithm	*e*
catch per unit effort	CPUE
coefficient of variation	CV
common test statistics	(F, t, χ^2, etc.)
confidence interval	CI
correlation coefficient (multiple)	R
correlation coefficient (simple)	r
covariance	cov
degree (angular)	°
degrees of freedom	df
expected value	*E*
greater than	>
greater than or equal to	≥
harvest per unit effort	HPUE
less than	<
less than or equal to	≤
logarithm (natural)	ln
logarithm (base 10)	log
logarithm (specify base)	log_2, etc.
minute (angular)	'
not significant	NS
null hypothesis	H_O
percent	%
probability	P
probability of a type I error (rejection of the null hypothesis when true)	α
probability of a type II error (acceptance of the null hypothesis when false)	β
second (angular)	"
standard deviation	SD
standard error	SE
variance	
population	Var
sample	var

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ABSTRACT

This report documents the Marine Stewardship Council's (MSC) conditions of recertification of sustainable fisheries for the Chignik Management Area salmon fishery. Two conditions were made by the MSC for the Chignik Area fishery to be certified. The first involves chum salmon data collection. The utility of chum salmon *Oncorhynchus keta* age information, the department's scale sampling policy and the relative magnitude of chum salmon harvests are detailed with respect to the MSC condition. The second condition highlights the need to document changes to methodology and databases concerning sockeye salmon *O. nerka* harvests and run apportionment. Those changes are documented in this report.

Key words: Marine Stewardship Council, Chignik, sockeye salmon, chum salmon, scale pattern analysis, scale sampling

INTRODUCTION

The Marine Stewardship Council (MSC) is a non-profit organization that certifies commercial fisheries to harness consumer preference for seafood products bearing the MSC label of approval (www.msc.org). Only commercial fisheries that meet environmental standards established by the MSC are certified. These fisheries are evaluated for environmentally responsible fishery management and harvesting practices.

The Alaska salmon fishery managed by the Alaska Department of Fish and Game (ADF&G) was originally certified by the MSC in September 2000. The certification expired after five years after which a recertification examination was conducted. The ADF&G reapplied for certification in 2005; however, due to changes to the methods that the MSC used to certify fisheries, the process has taken longer than anticipated. The Alaska salmon fishery has undergone the recertification process during 2006 though 2008.

A total of 67 conditions for recertification were developed for different management areas for MSC recertification of the Alaska salmon fishery. This report explains the two conditions for the Chignik Management Area (Figure 1) and documents the information required by the MSC.

MSC CONDITION 56

This condition for the Chignik Management Area states, "*Collect age-sex-size data for chum salmon, or provide a written explanation and justification that illustrates that the fishery specific harvests are not a significant component of the overall harvest of the stock.*"

Chum salmon harvests in the Chignik Management Area are minor compared to sockeye *Oncorhynchus nerka* and pink salmon *O. gorbuscha* harvests. Chum salmon *O. keta* are very rarely targeted by fishermen except on the rare occasion that a large ikura (salmon eggs) market is available in which case fish are harvested very close to their stream of origin late in the season. As there is a low level of industry interest, a relatively low level of harvest, continued large escapements, little concern of harvesting migrating stocks, and difficulty in collecting brood table-quality data, the department does not collect age-sex-size data for chum salmon.

WESTWARD REGION SCALE SAMPLING

The Westward Region of the ADF&G collects scale samples from several commercial fisheries to obtain age information and aid management of the commercial salmon fishery through one or more of five criteria:

1. Develop brood tables to evaluate long term production and forecasting;

2. Identify temporal shifts (within year) in age composition of a mixed stock catch;
3. Identify temporal shifts (between years) in age composition of a mixed stock catch;
4. Recognize specific stocks within a mixed stock catch when age markers are present;
5. Determine stock composition estimates using scale pattern analysis (SPA; Appendix A).

The department does not currently sample any chum salmon scales in the Westward Region for several reasons. While it is possible to generate brood tables to track production and forecast future runs of chum salmon, the cost of collecting samples from the commercial fishery and the escapement is prohibitive. Due to the fact that the gear used in this fishery is purse seine only, there may be very little selection on age classes; however, age class differences in the different districts of the Chignik Area are unknown. The only weir in the Chignik Management Area is in the Chignik River, but only minute numbers of chum salmon return to the Chignik River. It would be difficult to develop accurate brood tables without escapement samples collected from most of the major contributing chum salmon stocks. To attain escapement age compositions, annual sampling events would have to be conducted in several spawning systems throughout the region with most locations accessible with a helicopter only and at great cost.

Since chum salmon exhibit only three or four major age classes, using age to identify temporal shifts in a given area is problematic. Additionally, limited age classes preclude using age markers for stock identification.

CHIGNIK CHUM SALMON HARVESTS AND HARVEST TIMING

Most chum salmon in the Chignik Area are harvested in the Western District during July. Annual chum salmon harvest levels are strongly influenced by market conditions and the majority of the catch is taken incidental to sockeye salmon and to a lesser degree pink salmon. By regulation, the Western and Perryville districts are closed to commercial salmon fishing until July 5 (Figure 1). After this date commercial fishers typically move from the Chignik Bay and Central districts to the Western District to target returning sockeye and pink salmon. Despite comparatively high runs of chum salmon to local streams outside of the Western District (Table 1), few fishers target those stocks.

Chum salmon harvests have ranged from low of 505 fish in 2004 to a high of 580,332 fish in 1981 (Table 2). Recent harvests have been higher than the 5-year (2003-2007) harvest average, but below the 10-year (1998-2007), and 20-year (1988-2007) averages (Table 2).

MSC CONDITION 57

This condition for the Chignik Management Area states, "*Provide technical documentation for recent changes in run reconstruction data used to determine stock productivity. This should include: 1) methods used to alter Chignik sockeye catch data since the early 1970s, 2) changes in reported catch database, and 3) changes in brood tables.*"

This condition addresses several minor changes in the Chignik Management Area salmon fishery historical records. In general, these changes were made to improve the accuracy of the data, while one change concerning the Chignik River watershed stock separation methodology was altered due to budgetary restrictions. Analyses of the change in stock separation methodology indicated that there was no statistical significance between the old and new methods; however, the new method is likely less accurate in years of very early- or late-timed runs.

METHODS USED TO ALTER CHIGNIK SOCKEYE SALMON CATCH DATA

Changes to historical catch data are sometimes made in situations where the changes are thought to increase the accuracy of the data. In 2001, the department performed an audit of the Chignik run calculations from 1973 to 1999 (Appendix B). Specifically, the areas and times used to apportion catches to the early- and late- runs were examined and data were changed to ensure that the same areas and times were consistently followed and adhered to the post 1999 methodology. Tables 3 and 4 detail the data before and after the changes were made. Since 1999, the areas and times used to apportion catches have remained the same.

BROOD TABLE CHANGES

Changes in the historical data with respect to the areas and times used to apportion catch to the early- and late-runs also created the need to update the brood tables. The brood tables were changed in 2002 to reflect the changes made to the database in 2001. Tables 5 and 6 show the early- and late-run brood tables prior to the changes made in 2001 and Tables 7 and 8 show the early- and late-run brood tables after the 2001 changes.

CHANGES TO METHODS TO APPORTION SOCKEYE SALMON TO CHIGNIK AND BLACK LAKES

The Chignik River watershed has two temporally overlapping sockeye salmon runs: the Black Lake or early run that begins in late May and continues through late July and the Chignik Lake or late run that begins in late June and continues through September (Stichert 2008). The Black and Chignik lake stocks have separate escapement goals and controlling escapement for each run is necessary to effectively manage a sustainable fishery (Witteveen et al. 2007). Beginning in 1980 through 2003 a process called scale pattern analysis (SPA) was used to separate the overlapping portions of the Black Lake and Chignik Lake runs (Witteveen and Botz 2004). SPA is essentially differentiating salmon stocks by measuring the growth rings on their scales and using various discriminate function analyses to estimate proportions of each stock over time (Conrad 1983).

After the 2003 season, budget cuts resulted in the elimination of this project which necessitated a new method of separating the early and late runs. The department conducted an analysis of different possible stock separation methods and after accounting for several factors a simple cutoff date of July 4 was selected as a separation date for the run (Appendix C). Prior to July 5 all fish were considered early run while all fish after July 4 were considered late run.

The department was concerned that this method was not as accurate as using SPA and specifically, was not responsive to year-to-year changes in run timing. While the fixed-date separation may not be as responsive to run timing, it did not appear any less robust of an escapement estimate than SPA. An analysis of the total numbers of fish allocated the early run and late run using SPA versus the July 4 cutoff date was conducted and the conclusion was that there was no significant statistical difference between the two methods (Tables 9 and 10).

One important distinction in this analysis is the difference between the July 4 cutoff date and the previously reported "50/50 date". One of the notable points in the SPA run separation method was the 50/50 date. This date was the point during the season that the daily escapement was 50% Black Lake sockeye salmon and 50% Chignik Lake salmon. This date was reported to the public inseason and was usually used as a trigger for management staff to start focusing fisheries on the

Chignik Lake run. In contrast, the July 4 cutoff date is the date after which the Black Lake escapement is estimated to equal the Chignik Lake escapement that has already occurred. Because the runs are often different in magnitude and distribution, this date is not likely to be composed of 50% Black Lake fish and 50% Chignik Lake fish. Because the Black Lake run is usually larger than the Chignik Lake run, the July 4 cutoff date generally occurs before the 50/50 date.

CHANGES TO INTERIM GOALS

Changes made to the stock separation method created the need to modify the interim escapement goals for the Black Lake run. During the years that SPA was used for inseason management, SPA was not fully developed until early July. During June, prior to a SPA model being finished in a given season, the early-run goal was set in the preseason management plan at 350,000 to 400,000 fish by June 30. This date was a placeholder to provide management a target prior to receiving data from the SPA. When the SPA model was released in season, the timing of the 350,000 to 400,000 fish goal became dependent on the timing of the early run fish. In other words, the early-run goal was not necessarily based on a specific date after the SPA model was developed; the fishery was managed to make that goal. If run timing was late, the goal would be reached later; if run timing was early, the goal would be reached earlier. The management emphasis however, would shift to the late run after the 50/50 date. After the SPA analysis was ceased, we no longer had the means to estimate the run timing of the two runs, so we analyzed the most appropriate date that approximated the midpoint of the overlap and adjusted the 350,000 to 400,000 goal to that date. The interim goals were then adjusted to account for the temporal changes in the final goal.

CONCLUSION

While the department makes efforts to minimize any changes to historical information, occasionally changes that correct errors or increase the accuracy of the historical database are necessary. Most of these are documented in annual management reports, but some do not appear in publications. This reports documents some of those changes and provides a reprint of some changes that were made and published in previous annual management reports as requested by the MSC.

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TABLES

Table 1.– Estimated chum salmon escapement and objectives in the Chignik Management Area, by district and year, 1970 through 2007.

	District[b]					
Year[a]	Chignik Bay	Central	Eastern	Western	Perryville	Total
1970	21,000	23,400	126,000	49,700	13,000	233,100
1971	7,100	29,100	219,200	184,100	30,000	469,500
1972	3,300	14,200	107,400	59,000	11,500	195,400
1973	700	12,200	59,100	35,600	9,300	116,900
1974	2,100	18,100	76,300	39,400	12,500	148,400
1975	2,100	18,800	41,300	43,400	20,500	126,100
1976	2,400	17,800	122,300	55,000	8,900	206,400
1977	2,000	9,300	54,500	70,400	15,400	151,600
1978	2,100	13,800	55,800	27,300	5,300	104,300
1979	1,600	44,800	79,500	42,500	12,800	181,200
1980	300	34,200	107,000	56,500	29,100	227,100
1981	500	26,100	126,000	70,300	19,300	242,200
1982	1,400	49,400	145,400	35,400	23,600	255,200
1983	100	17,000	50,200	20,100	8,200	95,600
1984	300	35,400	214,700	73,800	46,000	370,200
1985	0	9,600	4,900	34,600	12,900	62,000
1986	0	31,000	8,500	5,300	7,700	52,500
1987	100	17,500	38,300	19,700	9,800	85,400
1988	15,300	55,800	221,900	27,400	41,400	361,800
1989	4,200	34,700	74,300	7,400	15,900	136,500
1990	1,500	28,000	139,700	28,800	55,800	253,800
1991	0	18,000	70,400	38,100	343,200	469,700
1992	100	173,100	306,900	53,300	40,300	573,700
1993	300	39,400	135,200	14,000	66,800	255,700
1994	1,500	102,600	129,200	23,000	126,000	382,300
1995	10,300	44,500	112,800	45,700	134,600	347,900
1996	16,400	45,100	130,500	44,500	132,000	368,500
1997	18,500	65,700	290,000	60,500	152,800	587,500
1998	4,500	32,000	97,700	30,600	214,500	379,300
1999	2,300	32,400	167,100	16,300	117,300	335,400
2000	100	22,700	216,000	12,700	51,900	303,400
2001	4,100	36,500	406,900	35,500	67,800	550,800
2002	67	11,615	174,850	17,082	32,020	235,634
2003	899	43,191	152,854	39,050	64,331	300,325
2004	376	30,310	277,240	3,100	38,492	349,518
2005	30,000	159,100	36,350	22,000	61,250	308,700
2006	1,099	3,450	53,940	6,000	29,000	93,489
2007	6,118	25,200	58,000	26,500	122,280	238,098
Management Objective	200	6,700	25,200	5,400	12,800	50,400
Averages						
1988-07	5,883	50,168	162,592	27,577	95,384	341,603
1998-07	4,956	39,647	164,093	20,883	79,887	309,466
2003-07	7,698	52,250	115,677	19,330	63,071	258,026

[a] From 1984 to 2003 aerial survey escapement estimates were computed by area-under-the-curve methods using a 15.0 day average stream life (Johnson and Barrett 1988). Starting 2004, estimates were computed using peak counts (Witteveen et al. 2005).

[b] All estimates were via aerial survey, with the exception of Chignik River which was included in the Chignik Bay District estimate.

Table 2.– Chignik Management Area chum salmon harvest (including home pack and the department's test fishery catches), by district and year, 1970 through 2007.

	District					
Year	Chignik Bay	Central	Eastern	Western	Perryville	Total
1970	1,660	28,628	241,108	139,551	26,305	437,252
1971	19,449	13,723	102,344	177,534	40,902	353,952
1972	18,178	1,566	27,723	18,535	12,296	78,298
1973	7,254	229	1,218	16	0	8,717
1974	17,317	13,516	255	3,224	0	34,312
1975	21,137	3,225	0	799	0	25,161
1976	19,237	3,358	10,020	33,051	15,737	81,403
1977	8,621	8,888	1,507	88,027	3,409	110,452
1978	15,020	10,317	17,451	45,991	32,110	120,889
1979	32,176	11,427	36,090	82,326	26,888	188,907
1980	19,944	38,902	56,805	91,868	45,002	252,521
1981	38,061	160,730	108,668	221,579	51,294	580,332
1982	16,034	33,669	64,513	253,299	22,581	390,096
1983	16,747	9,815	8,250	101,959	22,641	159,412
1984	8,173	8,150	21,134	25,364	482	63,303
1985	4,905	5,242	864	10,704	1,090	22,805
1986	18,167	29,502	17,880	74,070	37,021	176,640
1987	5,163	9,437	8,890	86,898	16,873	127,261
1988	7,013	39,316	77,511	102,730	41,205	267,775
1989	1,587	34	3	0	0	1,624
1990	11,460	113,741	27,463	91,603	25,737	270,004
1991	17,545	51,429	4,925	98,603	88,594	261,096
1992	12,711	45,569	61,209	65,466	37,179	222,134
1993	8,116	43,306	21,157	25,045	24,736	122,360
1994	25,250	69,552	4,333	94,116	34,025	227,276
1995	14,588	107,066	8,074	158,273	92,953	380,954
1996	782	46,993	19,837	36,303	16,976	120,891
1997	20,978	104,259	11,397	16,280	2,991	155,905
1998	7,352	43,191	5,180	41,425	31,848	128,996
1999	12,150	75,495	11,332	37,089	4,531	140,597
2000	8,389	66,904	8,045	34,823	2,796	120,957
2001	11,534	84,132	50,911	37,466	14,960	199,003
2002	3,949	9,643	513	40,337	117	54,559
2003	10,891	11,304	50	39,883	1,916	64,044
2004	499	6	0	0	0	505
2005	2,370	5,329	2	1,054	66	8,821
2006	2,303	9,455	776	49,096	0	61,630
2007	3,829	19,595	7,851	46,943	335	78,553
Averages						
1988-07	9,165	47,316	16,028	50,827	21,048	144,384
1998-07	6,327	32,505	8,466	32,812	5,657	85,767
2003-07	3,978	9,138	1,736	27,395	463	42,711

Table 3.– Sockeye salmon escapement, catch, and total run for Black Lake, Chignik Lake, and combined runs, 1973-1999 prior to database changes.

	Escapement and Catch								
	Black Lake			Chignik Lake			Combined		
Year	Escapement	Catch	Total	Escapement	Catch	Total	Escapement	Catch	Total
1973	533,047	569,854	1,102,901	247,144	396,114	643,258	780,191	965,968	1,746,159
1974	351,701	174,883	526,584	364,612	675,607	1,040,219	716,313	850,490	1,566,803
1975	308,914	4,019	312,933	314,084	421,414	735,498	622,998	425,433	1,048,431
1976	551,254	548,107	1,099,361	341,828	778,380	1,120,208	893,082	1,326,487	2,219,569
1977	482,247	439,693	921,940	463,561	1,696,767	2,160,328	945,808	2,136,460	3,082,268
1978	458,660	1,070,487	1,529,147	263,009	754,838	1,017,847	721,669	1,825,325	2,546,994
1979	385,694	207,122	592,816	317,889	944,964	1,262,853	703,583	1,152,086	1,855,669
1980	311,332	170,629	481,961	279,729	778,014	1,057,743	591,061	948,643	1,539,704
1981	438,540	779,755	1,218,295	301,092	1,509,959	1,811,051	739,632	2,289,714	3,029,346
1982	616,117	1,325,041	1,941,158	305,193	451,789	756,982	921,310	1,776,830	2,698,140
1983	426,177	977,548	1,403,725	441,561	1,467,060	1,908,621	867,738	2,444,608	3,312,346
1984	597,712	3,245,482	3,843,194	268,496	353,141	621,637	866,208	3,598,623	4,464,831
1985	377,516	650,340	1,027,856	369,262	490,151	859,413	746,778	1,140,491	1,887,269
1986	566,088	1,371,935	1,938,023	207,231	609,084	816,315	773,319	1,981,019	2,754,338
1987	589,291	1,949,867	2,539,158	214,452	482,311	696,763	803,743	2,432,178	3,235,921
1988	420,577	272,553	693,130	255,180	631,172	886,352	675,757	903,725	1,579,482
1989	384,004	234,839	618,843	557,171	1,063,042	1,620,213	941,175	1,297,881	2,239,056
1990	434,543	587,818	1,022,361	335,867	1,856,597	2,192,464	770,410	2,444,415	3,214,825
1991	657,511	1,714,835	2,372,346	382,587	751,291	1,133,878	1,040,098	2,466,126	3,506,224
1992	360,681	747,829	1,108,510	405,922	863,651	1,269,573	766,603	1,611,480	2,378,083
1993	364,263	926,863	1,291,126	333,114	1,322,984	1,656,098	697,377	2,249,847	2,947,224
1994	769,464	1,595,256	2,364,720	197,445	508,109	705,554	966,909	2,103,365	3,070,274
1995	366,163	660,282	1,026,445	373,757	1,522,406	1,896,163	739,920	2,182,688	2,922,608
1996	464,750	1,705,642	2,170,392	284,387	745,575	1,029,962	749,137	2,451,217	3,200,354
1997	396,668	234,612	631,280	378,950	608,484	987,434	775,618	843,096	1,618,714
1998	410,659	313,426	724,085	290,469	927,137	1,217,606	701,128	1,240,563	1,941,691
1999	457,425	2,032,538	2,489,963	258,541	1,713,756	1,972,297	715,966	3,746,294	4,462,294

Table 4.– Sockeye salmon escapement, catch, and total run for Black Lake, Chignik Lake, and combined runs, 1973-1999 after database changes.

	Escapement and Catch								
	Black Lake			Chignik Lake			Combined		
Year	Escapement	Catch	Total	Escapement	Catch	Total	Escapement	Catch	Total
1973	538,462	610,488	1,148,950	243,729	355,195	598,924	782,191	965,683	1,747,874
1974	364,603	204,722	569,325	313,343	648,283	961,626	677,946	853,005	1,530,951
1975	319,890	7,873	327,763	257,508	417,560	675,068	577,398	425,433	1,002,831
1976	548,953	599,341	1,148,293	281,810	727,043	1,008,854	830,763	1,326,384	2,157,147
1977	364,557	534,198	898,755	328,916	1,602,363	1,931,278	693,473	2,136,561	2,830,034
1978	419,732	940,188	1,359,919	262,815	885,173	1,147,988	682,547	1,825,361	2,507,908
1979	491,467	186,537	678,004	246,349	933,788	1,180,137	737,816	1,120,325	1,858,141
1980	369,580	73,742	443,322	294,481	849,980	1,144,461	664,061	923,722	1,587,783
1981	570,210	800,364	1,370,573	261,239	1,444,365	1,705,605	831,449	2,244,729	3,076,178
1982	616,117	1,325,041	1,941,158	305,193	451,789	756,982	921,310	1,776,830	2,698,140
1983	426,178	1,128,246	1,554,423	428,034	1,241,369	1,669,404	854,212	2,369,615	3,223,827
1984	597,713	2,919,984	3,517,697	267,861	613,075	880,936	865,574	3,533,059	4,398,633
1985	373,040	654,756	1,027,796	372,798	442,443	815,241	745,838	1,097,199	1,843,037
1986	557,772	1,364,295	1,922,067	215,547	587,561	803,108	773,319	1,951,856	2,725,175
1987	589,299	1,946,938	2,536,237	214,444	419,992	634,436	803,743	2,366,931	3,170,674
1988	420,580	272,074	692,654	255,177	554,304	809,481	675,757	826,379	1,502,136
1989	384,001	234,237	618,238	557,174	929,535	1,486,709	941,175	1,163,772	2,104,947
1990	434,550	582,520	1,017,070	335,860	1,747,435	2,083,295	770,410	2,329,955	3,100,365
1991	662,660	1,711,683	2,374,343	377,438	661,025	1,038,463	1,040,098	2,372,708	3,412,806
1992	360,681	746,341	1,107,022	403,755	777,311	1,181,066	764,436	1,523,652	2,288,088
1993	364,261	926,892	1,291,154	333,116	1,199,050	1,532,166	697,377	2,125,942	2,823,319
1994	769,465	1,595,176	2,364,641	197,444	416,377	613,821	966,909	2,011,553	2,978,462
1995	366,495	666,800	1,033,295	373,425	1,315,862	1,689,287	739,920	1,982,662	2,722,582
1996	464,748	1,688,224	2,152,972	284,389	705,657	990,046	749,137	2,393,881	3,143,018
1997	396,668	234,492	631,160	378,950	535,191	914,141	775,618	769,683	1,545,301
1998	410,659	313,027	723,686	290,469	816,851	1,107,320	701,128	1,129,878	1,831,006
1999	457,424	2,022,354	2,479,777	258,542	1,723,915	1,982,458	715,966	3,746,269	4,462,235

Table 5.– Black Lake sockeye salmon brood table prior to changes made in 2001.

Year	Parent Escapement	0.2	1.1	0.3	1.2	2.1	1.3	2.2	1.4	2.3	3.2	2.4	3.3	Other	Total
1915												1,202	1,202		2,404
1916									9,315	68,559	37	15	0		77,926
1917							318,491	20,666	576	18,747	0	0	0	0	358,480
1918				0	12,960	0	43,803	6,984	0	49,097	0	0	138	0	112,982
1919		0	0	0	15,073	0	92,073	28,499	16	74,062	30	0	324	0	210,077
1920		0	0	0	63,251	0	422,288	28,279	0	111,422	6,511	0	273	0	632,024
1921		0	0	0	122,550	0	258,628	113,493	5,873	255,927	0	0	0	0	756,471
1922	86,421	0	0	0	40,685	0	659,040	56,121	0	202,612	2,465	1,222	1,669	0	963,814
1923	4,642	0	0	0	18,213	0	172,343	53,445	2,677	132,776	410	436	59	0	380,359
1924	121,983	0	0	0	85,083	0	1,206,555	8,855	426	19,931	939	384	384	0	1,322,557
1925	386,364	0	0	0	1,529	0	54,164	9,924	384	50,707	937	17	0	0	117,662
1926	289,009	0	0	0	7,544	420	104,094	45,572	11,714	352,025	7,117	0	1,708	0	530,194
1927	857,881	0	0	0	99,929	66	2,375,878	85,253	721	107,239	165	3,699	4,234	0	2,677,184
1928	507,353	0	0	0	23,860	0	304,338	49,284	9,848	428,369	2,755	409	2,118	0	820,981
1929	995,832	0	0	0	9,910	0	918,487	58,777	5,626	60,214	865	144	144	0	1,054,167
1930	92,955	0	0	0	23,769	0	286,339	13,886	6,663	43,297	3,527	4	0	0	377,485
1931	96,201	0	0	0	33,685	943	923,763	46,710	28	122,389	0	655	58	0	1,128,231
1932	2,151,734	0	0	0	50,602	0	191,354	36,823	10,350	43,060	291	8,584	234	0	341,298
1933	223,913	0	0	0	62,079	0	247,818	7,609	138,675	164,540	0	625	54	0	621,400
1934	866,890	0	0	0	16,228	4	1,583,632	6,057	9,886	40,971	276	1,299	113	0	1,658,466
1935	194,636	0	10	0	68,710	0	235,971	7,188	20,562	85,058	572	1,508	130	0	419,709
1936	548,039	0	0	0	15,422	3	490,061	14,873	23,865	98,553	661	2,346	201	0	645,985
1937	205,613	0	9	0	32,001	7	567,984	17,179	37,146	153,156	1,026	960	82	0	809,550
1938	175,972	0	19	0	37,059	7	882,938	26,618	15,193	62,552	418	706	60	0	1,025,570
1939	1,142,852	0	22	0	57,563	12	360,712	10,840	11,171	45,926	307	2,470	209	0	489,232
1940	176,307	0	35	0	23,499	5	264,904	7,938	39,130	160,651	1,070	7,513	634	0	505,379
1941	374,420	0	14	0	17,246	3	926,890	27,697	119,048	488,137	3,247	1,196	101	0	1,583,579
1942	442,981	0	11	0	60,302	12	2,817,023	83,954	18,948	77,598	515	684	58	0	3,059,105
1943	701,859	0	36	0	183,156	37	447,919	13,315	10,839	44,522	297	499	38	0	700,658
1944	291,844	0	111	0	29,106	6	256,848	7,683	7,947	31,664	203	482	43	0	334,093
1945	217,882	0	18	0	16,715	3	183,734	5,143	7,619	31,784	216	275	27	0	245,534
1946	774,130	0	10	0	11,775	2	182,835	5,644	4,307	18,686	133	707	64	0	224,163
1947	2,386,733	0	7	0	11,988	2	106,718	3,550	11,150	46,809	320	525	43	0	181,112
1948	384,637	0	7	0	7,129	1	268,953	8,407	8,346	33,877	223	352	0	0	327,295
1949	213,269	0	4	0	17,688	4	195,878	5,713	0	89,095	0	0	152	0	308,534
1950	206,270	0	11	0	12,671	3	287,407	12,644	1,862	76,722	648	373	286	0	392,627
1951	125,126	0	8	0	46,798	0	448,360	3,404	2,319	124,345	0	455	0	0	625,689
1952	34,155	0	0	0	4,390	0	137,957	3,423	208	81,691	0	639	2,512	0	230,820
1953	168,375	0	0	0	1,024	32	154,589	17,848	1,625	180,887	252	0	1,350	0	357,607
1954	184,953	0	143	0	6,468	0	50,272	10,720	515	72,973	9	312	1,009	0	142,421
1955	256,757	0	783	0	30,302	0	430,793	3,476	339	88,693	109	0	0	0	554,495
1956	289,096	0	17	0	16,499	0	81,569	14,910	9	90,001	0	196	4,967	0	208,168
1957	192,479	0	0	0	6,559	161	117,979	10,507	52	210,686	3,641	21	906	0	350,512

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Table 5.– Page 2 of 2.

Year	Parent Escapement	0.2	1.1	0.3	1.2	2.1	1.3	2.2	1.4	2.3	3.2	2.4	3.3	Other	Total	Return/ Spawner
1959	112,226	0	1,522	0	31,039	142	148,403	13,872	402	144,581	874	58	54	0	340,947	3.04
1960	251,567	0	124	0	55,546	221	610,592	32,598	6,221	65,418	49	606	3,383	0	774,756	3.08
1961	140,714	0	276	0	14,301	1	387,053	3,483	536	164,278	486	1,020	209	0	571,645	4.06
1962	167,602	0	698	0	8,379	0	257,371	25,726	3,194	395,626	1,524	954	0	0	693,473	4.14
1963	332,536	0	0	0	29,538	173	448,298	17,628	905	199,104	0	2,506	551	0	698,703	2.10
1964	137,073	0	37	0	13,311	3,735	190,972	133,203	3,809	409,973	414	0	271	0	755,726	5.51
1965	307,192	0	394	0	102,570	421	1,535,858	80,851	3,332	201,220	271	497	22,731	0	1,948,144	6.34
1966	383,545	0	1,631	0	65,254	378	990,567	15,248	2,193	225,660	28	0	2,504	0	1,303,463	3.40
1967	328,000	0	2,728	0	16,157	163	99,357	6,078	13,406	96,629	1,537	0	0	0	236,054	0.72
1968	342,343	0	271	0	12,997	0	971,408	4,519	2,163	161,664	1,960	0	1,663	0	1,156,644	3.38
1969	366,589	0	0	0	12,747	153	279,429	63,258	1,313	84,120	486	0	2,251	0	443,757	1.21
1970	536,257	0	0	0	17,281	261	195,050	8,163	4,614	192,247	621	0	3,698	0	421,934	0.79
1971	671,668	0	569	0	22,138	0	800,515	67,483	3,873	454,039	385	264	6,763	0	1,356,029	2.02
1972	326,320	0	0	0	31,630	0	423,794	16,474	3,195	587,997	4,596	831	2,564	0	1,071,082	3.28
1973	533,047	0	0	0	19,627	0	753,970	121,231	0	324,538	1,425	511	1,812	0	1,223,113	2.29
1974	351,701	0	51	0	50,797	334	123,590	117,544	116	305,094	551	452	2,727	0	601,256	1.71
1975	308,914	0	0	0	19,977	1,826	71,732	55,434	1,010	447,233	1,057	396	34	2,437	601,137	1.95
1976	551,254	0	520	0	44,085	88	669,395	24,810	816	135,036	0	0	334	11,778	886,860	1.61
1977	482,247	0	102	0	59,211	389	1,687,898	12,701	6,990	337,281	0	3,492	1,655	44,852	2,154,571	4.47
1978	458,660	0	235	0	55,123	3,060	448,274	61,734	6,664	354,902	0	0	210	15,138	945,339	2.06
1979	385,694	0	1,241	0	533,050	671	3,195,846	57,155	4,133	68,046	223	422	805	1,350	3,862,941	10.02
1980	311,332	0	255	120,421	99,989	1,187	641,668	151,574	1,503	741,614	2,098	943	1,113	4,847	1,767,213	5.68
1981	438,540	0	532	0	155,923	1,112	938,072	75,567	4,289	664,383	510	1,112	259	2,819	1,844,578	4.21
1982	616,117	0	121	0	172,993	2,021	1,627,753	134,483	2,133	391,690	0	394	0	194	2,331,780	3.78
1983	426,177	0	0	19,136	79,674	3,905	209,772	37,475	285	211,457	2	3,596	0	466	565,767	1.33
1984	597,712	478	2,279	1,225	46,148	2,194	324,901	42,078	2,605	210,908	1,216	703	2,461	0	637,196	1.07
1985	377,516	156	501	510	36,677	638	376,202	73,568	20,665	249,837	1,091	1,202	9,240	3,500	773,787	2.05
1986	566,088	384	1,517	6,384	342,057	0	1,893,213	55,260	2,978	203,218	11,147	5,791	1,147	45	2,523,141	4.46
1987	589,291	2,325	0	961	145,616	1,027	727,158	75,666	8,944	433,856	2,904	6,072	31,613	745	1,436,887	2.44
1988	420,577	0	1,467	670	70,153	1,885	491,967	122,690	5,445	961,154	1,426	798	444	256	1,658,355	3.94
1989	384,004	32	4,416	5,832	213,429	2,749	1,035,809	143,882	4,145	268,597	1,258	2,032	20,155	1,452	1,703,788	4.44
1990	434,543	1,004	557	34,085	137,435	5,125	458,197	179,469	5,622	679,455	23	3,314	7,078	579	1,511,943	3.46
1991	657,511	720	502	1,823	108,526	333	1,198,209	36,077	1,208	123,111	1,082	620	2,998	811	1,472,402	2.05
1992	360,681	1,830	446	113,033	51,371	10,393	371,002	67,350	1,389	294,881	10,212	0	5,113	606	1,288,307	3.57
1993	364,263	2,857	104	10,112	44,158	1,372	193,425	127,297	978	521,812	2,128	1,245	671	0	1,270,422	3.49
1994	766,909	234	653	0	89,234	1,093	1,196,731	220,451	13,534	499,805	52	600	97	566	2,789,959	3.64
1995	366,163	1,520	1,262	30,859	504,089	0	1,357,291	20,147	7,092	132,288	0					
1996	450,725	7,233	569	75,045	55,625	0	1,091,072	14,862								
1997	396,668	1,303	0	7,159	50,455	838										
1998	410,659	149	631													
1999	457,425															
2000	519,661															
2001	744,013															

Table 6.– Chignik Lake sockeye salmon brood table prior to changes made in 2001.

Year	Parent Escapement	0.2	1.1	0.3	1.2	2.1	1.3	2.2	1.4	2.3	3.2	2.4	3.3	Other	Total
1915												4,514	4,514		9,028
1916									11,874	690,450	9,120	2,007	0	0	713,451
1917							339,637	149,163	296	274,036	0	0	0	0	763,132
1918				0	44,358	0	201,318	195,611	0	999,888	0	2,948	2,966	0	1,447,089
1919		0	0	0	100,404	2,425	243,024	286,119	2,492	423,094	8,270	0	5,828	0	1,071,656
1920		0	0	0	148,914	0	435,826	137,704	2,509	300,319	20,713	0	1,567	0	1,047,552
1921		0	0	0	101,251	0	216,728	278,711	4,085	193,620	2,245	955	3,396	0	800,991
1922	352,807	0	0	0	43,667	0	382,956	73,351	0	991,979	14,972	2,886	4,175	0	1,513,986
1923	213,781	0	0	0	74,884	218	410,194	245,187	2,360	577,390	1,111	1,647	2,376	0	1,315,367
1924	910,521	0	0	0	126,685	1,819	1,003,422	8,350	1,115	102,217	5,830	425	55	0	1,249,918
1925	677,566	0	0	0	3,736	0	51,222	195,414	332	427,580	7,817	5,367	456	0	691,924
1926	695,314	0	0	0	25,764	919	279,018	304,619	3,461	879,220	3,821	55	2,246	0	1,499,396
1927	429,525	0	207	0	113,952	1,499	951,950	100,633	744	203,942	1,586	1,225	5,557	0	1,381,295
1928	1,020,520	0	0	0	40,063	0	353,506	77,224	12,047	300,603	3,129	1,042	1,618	0	789,232
1929	914,307	0	0	0	16,254	0	584,561	38,873	5,675	361,557	1,165	2,192	1,251	0	1,011,781
1930	359,405	0	0	0	26,688	0	426,128	41,867	6,177	344,419	16,565	2,065	0	0	863,909
1931	631,986	0	0	0	30,856	2,454	296,899	138,440	3,747	264,858	0	2,678	635	0	740,567
1932	1,113,859	0	0	0	24,809	0	475,759	46,764	8,530	185,288	2,049	13,674	1,502	0	758,375
1933	310,088	0	0	0	35,679	0	311,946	35,705	48,795	321,467	0	1,267	301	0	755,160
1934	447,642	0	0	0	19,716	90	708,212	33,934	4,066	88,027	969	4,299	1,026	0	860,339
1935	462,469	0	69	0	37,642	308	148,352	16,893	13,842	299,288	3,284	4,082	976	0	524,736
1936	376,838	0	0	0	9,342	43	504,624	57,326	13,186	284,707	3,117	9,326	2,233	0	883,904
1937	406,618	0	33	0	31,723	145	480,250	54,435	30,220	651,642	7,116	2,664	639	0	1,258,867
1938	305,827	0	111	0	30,143	137	1,099,657	124,382	8,660	186,504	2,032	1,128	270	0	1,453,024
1939	512,754	0	106	0	68,919	315	314,851	35,542	3,674	79,035	859	5,420	1,305	0	510,026
1940	152,957	0	244	0	19,705	90	133,474	15,039	17,705	380,481	4,130	10,049	2,422	0	583,339
1941	531,904	0	70	0	8,342	38	642,782	72,293	32,912	706,532	7,654	2,225	537	0	1,473,385
1942	516,621	0	30	0	40,124	183	1,194,007	134,060	7,305	156,659	1,695	4,662	1,112	0	1,539,837
1943	1,205,418	0	143	0	74,442	340	264,830	29,686	15,007	324,527	3,562	5,405	1,321	0	719,263
1944	351,212	0	266	0	16,492	75	547,139	62,179	18,110	385,087	4,101	2,886	711	0	1,037,046
1945	151,326	0	59	0	34,405	157	652,782	72,138	9,784	207,054	2,186	1,246	315	0	980,126
1946	739,884	0	121	0	40,246	183	351,541	38,531	4,401	91,579	937	1,531	371	0	529,441
1947	1,393,990	0	147	0	21,549	98	156,343	16,644	5,048	108,068	1,165	1,316	333	0	310,711
1948	313,319	0	80	0	9,390	42	182,792	20,430	4,658	96,858	989	826	0	0	316,065
1949	574,715	0	36	0	11,360	52	165,402	17,581	1,766	103,345	0	496	650	0	300,688
1950	861,070	0	41	0	9,924	45	199,966	31,411	2,206	245,826	407	2,903	1,820	0	494,549
1951	490,899	0	38	0	33,082	0	618,729	13,748	7,046	242,042	0	1,028	0	0	915,713
1952	260,540	0	0	0	22,213	0	258,747	30,836	986	229,563	0	3,932	8,403	0	554,680
1953	221,408	0	0	0	9,167	428	125,399	32,350	470	396,916	1,935	934	5,424	0	573,023
1954	277,912	0	547	0	2,848	0	39,658	75,361	771	418,442	804	1,661	5,069	0	545,161
1955	201,409	0	369	0	32,187	0	303,988	32,708	168	363,162	1,252	0	0	0	733,834
1956	483,024	0	1,330	0	12,515	0	106,327	36,113	435	221,169	0	1,349	4,781	0	384,019

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Table 6.–Page 2 of 2.

Year	Parent Escapement	0.2	1.1	0.3	1.2	2.1	1.3	2.2	1.4	2.3	3.2	2.4	3.3	Other	Total
1957	328,779	0	0	0	17,746	622	232,393	109,475	351	332,661	2,104	1,189	1,319	0	697,860
1958	212,594	0	1,459	0	50,630	0	23,204	139,797	0	418,960	980	93	432	0	635,555
1959	308,645	0	3,286	0	18,094	907	109,165	81,640	117	197,975	738	689	187	0	413,025
1960	357,230	0	146	0	24,446	491	122,278	8,273	1,314	210,884	141	1,618	12,824	0	382,415
1961	254,970	0	718	0	1,899	799	109,935	18,702	220	401,733	2,698	5,335	2,420	0	544,459
1962	324,860	0	123	0	4,312	0	44,074	69,811	998	692,188	1,074	1,109	0	0	813,689
1963	200,314	0	0	0	5,536	1,300	103,116	68,605	29	243,939	0	1,501	867	0	424,893
1964	166,625	0	88	0	6,607	4,550	24,880	65,639	700	138,282	943	205	6,114	0	248,008
1965	163,151	0	1,636	0	25,157	5,547	159,113	57,942	382	650,181	1,028	659	96,111	0	997,756
1966	183,525	0	1,715	0	14,517	925	300,759	30,263	461	413,807	2,453	0	18,073	0	782,974
1967	189,000	0	501	0	6,187	768	78,308	31,097	701	482,538	2,780	1,342	0	0	604,221
1968	244,836	0	914	0	3,835	0	115,840	20,435	636	583,517	15,603	2,691	30,092	0	773,902
1969	132,055	0	0	0	1,239	1,062	85,064	270,966	818	487,805	7,288	0	16,722	0	871,247
1970	119,952	0	0	0	18,234	12,035	27,646	151,089	1,318	461,271	12,205	0	19,870	0	703,668
1971	232,501	0	1,500	0	15,448	12,620	185,532	410,628	236	1,898,372	4,096	2,842	13,887	0	2,545,161
1972	231,270	0	0	0	30,087	2,445	120,639	96,178	98	718,493	30,779	267	3,698	0	1,002,684
1973	247,144	0	0	0	5,778	10,740	56,736	173,028	0	919,784	3,852	1,248	4,756	0	1,175,922
1974	364,612	0	4,420	0	19,284	2,764	105,493	196,981	51	677,611	2,036	2,316	9,262	2,703	1,022,921
1975	314,084	0	0	0	24,550	7,125	123,634	185,390	914	859,629	3,573	6,449	2,334	7,609	1,221,207
1976	341,828	0	1,103	0	59,255	807	775,826	94,346	2,484	499,554	0	3,117	10	5,083	1,441,585
1977	463,561	0	252	0	52,795	3,975	155,472	59,987	1,958	1,207,619	0	2,034	789	7,477	1,492,358
1978	263,009	0	422	0	16,755	5,822	259,993	318,606	686	278,532	490	1,752	176	239	883,473
1979	317,889	0	2,029	0	102,991	5,057	281,909	28,124	1,235	278,237	388	1,469	784	3,223	705,446
1980	279,729	0	1,794	8,287	13,217	6,060	156,838	320,949	632	448,135	3,096	830	1,070	1,189	962,097
1981	301,092	0	1,116	0	88,980	5,093	232,004	74,324	664	370,421	151	649	74	35	773,511
1982	305,193	0	2,542	0	51,480	3,199	194,469	108,490	740	582,904	160	1,383	0	301	945,668
1983	441,561	0	0	2,715	12,125	3,824	148,143	109,807	208	1,105,502	807	11,621	76	0	1,394,828
1984	268,496	120	914	552	30,409	10,724	150,188	324,007	2,480	1,638,859	1,743	9,695	7,155	597	2,177,443
1985	369,262	98	689	207	18,638	16,398	174,283	161,966	6,682	501,843	1,161	4,112	3,789	173	890,039
1986	207,231	103	2,745	13,060	179,104	321	345,786	175,958	1,834	497,777	7,787	12,896	2,149	619	1,240,139
1987	214,452	6,253	686	1,066	72,172	9,757	457,744	225,494	6,045	1,037,042	6,866	7,292	71,800	125	1,902,342
1988	255,180	0	2,430	1,115	57,578	3,326	295,438	109,596	2,118	206,346	4,081	10,594	8,802	1,268	702,692
1989	557,171	418	7,979	9,244	171,035	4,773	273,461	105,477	3,988	1,202,092	7,408	11,544	88,753	320	1,886,492
1990	335,867	447	442	6,049	26,006	1,321	366,364	186,817	1,947	463,728	1,800	2,170	16,440	890	1,074,421
1991	382,587	134	201	1,008	105,101	1,934	297,675	109,027	649	480,415	2,956	5,387	4,350	4,111	1,012,948
1992	405,922	628	1,107	22,469	18,620	12,535	219,422	204,719	2,436	572,892	62,690	1,064	20,603	377	1,117,895
1993	333,114	474	500	4,331	31,962	19,220	146,287	340,049	2,060	1,015,145	4,771	1,168	68	170	1,566,205
1994	197,445	85	954	0	60,598	7,715	448,915	290,605	3,521	440,554	272	2,257	1,920	226	1,257,622
1995	373,757	391	1,587	5,600	182,505	0	351,342	33,724	3,906	770,988	4,312				
1996	284,387	974	55	45,570	46,210	115	740,706	40,125							
1997	363,743	3,101	170	3,188	35,290	1,847									
1998	278,742	173	1,787												
1999	258,541														
2000	285,614														
2001	392,095														

Table 7.– Black Lake sockeye salmon brood table after changes made in 2001.

Year	Parent Escapement	0.2	1.1	0.3	1.2	2.1	1.3	2.2	0.4	1.4	2.3	3.2	2.4	3.3	Other	Total
1915		0	0	0	0	0	0	0	0	0	0	0	1,202	1,202	0	2,404
1916		0	0	0	0	0	0	0	0	9,315	68,559	37	15	0	0	77,926
1917		0	0	0	0	0	318,491	20,666	0	576	18,747	0	0	0	0	358,480
1918		0	0	0	12,960	0	43,803	6,984	0	0	49,097	0	0	138	0	112,982
1919		0	0	0	15,073	0	92,073	28,499	0	16	74,062	30	0	324	0	210,077
1920		0	0	0	63,251	0	422,288	28,279	0	0	111,422	6,511	0	273	0	632,024
1921		0	0	0	122,550	0	258,628	113,493	0	5,873	255,927	0	0	0	0	756,471
1922	86,421	0	0	0	40,685	0	659,040	56,121	0	0	202,612	2,465	1,222	1,669	0	963,814
1923	4,642	0	0	0	18,213	0	172,343	53,445	0	2,677	132,776	410	436	59	0	380,359
1924	121,983	0	0	0	85,083	0	1,206,555	8,855	0	426	19,931	939	384	384	0	1,322,557
1925	386,364	0	0	0	1,529	0	54,164	9,924	0	384	50,707	937	17	0	0	117,662
1926	289,009	0	0	0	7,544	420	104,094	45,572	0	11,714	352,025	7,117	0	1,708	0	530,194
1927	857,881	0	0	0	99,929	66	2,375,878	85,253	0	721	107,239	165	3,699	4,234	0	2,677,184
1928	507,353	0	0	0	23,860	0	304,338	49,284	0	9,848	428,369	2,755	409	2,118	0	820,981
1929	995,832	0	0	0	9,910	0	918,487	58,777	0	5,626	60,214	865	144	144	0	1,054,167
1930	92,955	0	0	0	23,769	0	286,339	13,886	0	6,663	43,297	3,527	4	0	0	377,485
1931	96,201	0	0	0	33,685	943	923,763	46,710	0	28	122,389	0	655	58	0	1,128,231
1932	2,151,734	0	0	0	50,602	0	191,354	36,823	0	10,350	43,060	291	8,584	234	0	341,298
1933	223,913	0	0	0	62,079	0	247,818	7,609	0	138,675	164,540	0	625	54	0	621,400
1934	866,890	0	0	0	16,228	4	1,583,632	6,057	0	9,886	40,971	276	1,299	113	0	1,658,466
1935	194,636	0	10	0	68,710	0	235,971	7,188	0	20,562	85,058	572	1,508	130	0	419,709
1936	548,039	0	0	0	15,422	3	490,061	14,873	0	23,865	98,553	661	2,346	201	0	645,985
1937	205,613	0	9	0	32,001	7	567,984	17,179	0	37,146	153,156	1,026	960	82	0	809,550
1938	175,972	0	19	0	37,059	7	882,938	26,618	0	15,193	62,552	418	706	60	0	1,025,570
1939	1,142,852	0	22	0	57,563	12	360,712	10,840	0	11,171	45,926	307	2,470	209	0	489,232
1940	176,307	0	35	0	23,499	5	264,904	7,938	0	39,130	160,651	1,070	7,513	634	0	505,379
1941	374,420	0	14	0	17,246	3	926,890	27,697	0	119,048	488,137	3,247	1,196	101	0	1,583,579
1942	442,981	0	11	0	60,302	12	2,817,023	83,954	0	18,948	77,598	515	684	58	0	3,059,105
1943	701,859	0	36	0	183,156	37	447,919	13,315	0	10,839	44,522	297	499	38	0	700,658
1944	291,844	0	111	0	29,106	6	256,848	7,683	0	7,947	31,664	203	482	43	0	334,093
1945	217,882	0	18	0	16,715	3	183,734	5,143	0	7,619	31,784	216	275	27	0	245,534
1946	774,130	0	10	0	11,775	2	182,835	5,644	0	4,307	18,686	133	707	64	0	224,163
1947	2,386,733	0	7	0	11,988	2	106,718	3,550	0	11,150	46,809	320	525	43	0	181,112
1948	384,637	0	7	0	7,129	1	268,953	8,407	0	8,346	33,877	223	352	0	0	327,295
1949	213,269	0	4	0	17,688	4	195,878	5,713	0	0	89,095	0	0	152	0	308,534
1950	206,270	0	11	0	12,671	3	287,407	12,644	0	1,862	76,722	648	373	286	0	392,627
1951	125,126	0	8	0	46,798	0	448,360	3,404	0	2,319	124,345	0	455	0	0	625,689
1952	34,155	0	0	0	4,390	0	137,957	3,423	0	208	81,691	0	639	2,512	0	230,820
1953	168,375	0	0	0	1,024	32	154,589	17,848	0	1,625	180,887	252	0	1,350	0	357,607
1954	184,953	0	143	0	6,468	0	50,272	10,720	0	515	72,973	9	312	1,009	0	142,421
1955	256,757	0	783	0	30,302	0	430,793	3,476	0	339	88,693	109	0	0	0	554,495
1956	289,096	0	17	0	16,499	0	81,569	14,910	0	9	90,001	0	196	4,967	0	208,168
1957	192,479	0	0	0	6,559	161	117,979	10,507	0	52	210,686	3,641	21	906	0	350,512
1958	120,862	0	905	0	19,146	0	79,955	81,992	0	0	60,132	77	61	103	0	242,370
1959	112,226	0	1,522	0	31,039	142	148,403	13,872	0	402	144,581	874	58	54	0	340,946
1960	251,567	0	124	0	55,546	221	610,591	32,598	0	6,221	65,418	49	606	3,383	0	774,756
1961	140,714	0	276	0	14,301	1	387,053	3,483	0	536	164,278	486	1,020	209	0	571,645
1962	167,602	0	698	0	8,379	0	257,371	25,726	0	3,194	395,626	1,524	954	0	0	693,473
1963	332,536	0	0	0	29,538	173	448,298	17,628	0	905	199,104	0	2,506	551	0	698,703

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Table 7.— Page 2 of 2.

Year	Parent Escapement	0.2	1.1	0.3	1.2	2.1	1.3	2.2	0.4	1.4	2.3	3.2	2.4	3.3	Other	Total
1964	137,073	0	37	0	13,311	3,735	190,971	133,203	0	3,809	409,974	414	0	271	0	755,726
1965	307,192	0	394	0	102,570	421	1,535,858	80,851	0	3,332	201,220	271	497	22,731	0	1,948,144
1966	383,545	0	1,631	0	65,254	378	990,567	15,248	0	2,193	225,659	28	0	2,609	0	1,303,567
1967	328,000	0	2,728	0	16,157	163	99,357	6,078	0	13,965	100,663	1,601	0	0	0	240,712
1968	342,343	0	271	0	12,997	0	1,011,967	4,707	0	2,338	174,786	2,119	0	1,742	0	1,210,927
1969	366,589	0	0	0	13,279	160	302,109	68,392	0	1,375	88,106	509	0	2,351	0	476,282
1970	536,257	0	0	0	18,684	283	204,293	8,550	0	4,819	200,804	648	0	3,605	0	441,685
1971	671,668	0	615	0	23,187	0	836,146	70,487	0	3,775	442,621	375	235	6,015	0	1,383,455
1972	326,320	0	0	0	33,038	0	413,137	16,060	0	2,842	522,924	4,087	951	2,933	0	995,971
1973	538,462	0	0	0	19,133	0	670,530	107,814	0	0	371,174	1,630	472	1,675	0	1,172,428
1974	364,603	0	50	0	45,176	297	141,350	134,435	0	107	282,061	510	513	3,098	0	607,596
1975	319,890	0	0	0	22,848	2,088	66,316	51,249	0	1,148	508,045	1,200	405	35	2,492	655,827
1976	548,953	0	595	0	40,756	81	760,415	28,183	0	834	138,053	0	0	371	13,073	982,361
1977	364,557	0	95	0	67,262	442	1,725,603	12,985	0	7,759	374,386	0	3,161	1,498	40,594	2,233,783
1978	419,732	0	267	0	56,354	3,129	497,590	68,525	0	6,032	321,208	0	0	208	14,987	968,298
1979	491,467	0	1,269	0	591,692	745	2,892,436	51,728	0	4,092	67,367	220	419	799	1,340	3,612,107
1980	369,580	0	283	108,988	90,497	1,074	635,271	150,063	0	1,492	736,108	2,082	940	1,110	4,833	1,732,741
1981	570,210	0	482	0	154,368	1,101	931,107	75,006	0	4,276	662,410	509	1,107	258	2,808	1,833,432
1982	616,117	0	120	0	171,708	2,006	1,622,919	134,083	0	2,124	390,096	0	393	0	193	2,323,643
1983	426,178	0	0	19,079	79,437	3,893	208,918	37,322	0	285	211,184	2	3,588	0	465	564,174
1984	597,713	476	2,273	1,220	45,960	2,185	324,482	42,024	0	2,599	210,441	1,213	704	2,463	0	636,040
1985	373,040	155	499	509	36,630	637	375,369	73,405	0	20,683	250,052	1,092	1,197	9,205	3,487	772,920
1986	557,772	384	1,515	6,370	341,300	0	1,894,843	55,308	0	2,967	202,442	11,104	5,792	1,147	45	2,523,215
1987	589,299	2,320	0	962	145,741	1,028	724,381	75,377	0	8,946	433,936	2,905	6,074	31,621	745	1,434,036
1988	420,580	0	1,468	667	69,885	1,878	492,058	122,713	0	5,446	961,409	1,426	804	447	258	1,658,460
1989	384,001	32	4,399	5,833	213,468	2,750	1,036,084	143,920	0	4,174	270,475	1,267	2,063	20,461	1,474	1,706,400
1990	434,550	1,004	557	34,094	137,472	5,126	461,400	180,724	0	5,707	689,768	23	3,314	7,077	579	1,526,844
1991	662,660	720	502	1,836	109,285	335	1,216,395	36,625	0	1,208	123,093	1,082	619	2,994	810	1,495,503
1992	360,681	1,843	449	114,749	52,151	10,551	370,948	67,340	0	1,387	294,451	10,197	0	5,091	603	929,759
1993	364,261	2,900	106	10,111	44,152	1,372	193,143	127,112	0	974	519,551	2,119	1,299	700	0	903,537
1994	769,465	234	653	0	89,104	1,091	1,191,546	219,496	0	14,117	521,350	54	601	97	567	2,038,909
1995	366,495	1,518	1,260	30,725	501,905	0	1,415,799	21,015	0	7,099	132,418	0	2,650	2,399	343	2,117,130
1996	464,748	7,202	567	78,280	58,023	0	1,092,142	14,877	0	12,799	302,104	1,115	812	2,456	0	1,570,375
1997	396,668	1,359	0	7,166	50,504	839	488,972	49,781	0	3,277	174,087	193	0	0	0	776,179
1998	410,659	149	632	3,122	200,142	3	643,270	29,951	0	1,015	111,141	0	0	0	0	989,424
1999	457,424	1,906	81	18,112	115,606	876	630,749	70,220	0	734	176,623	0	0	0	0	1,014,906
2000	536,141	1,184	228	10,185	257,222	297	1,101,146	49,689	0	8,102	150,557	0	3,513	0	0	1,582,123
2001	744,013	5,364	0	59,606	77,174	0	523,867	31,580	0	10,669	164,276	0				
2002	380,701	0	0	6,231	55,979	0	248,106	1,416	1,717							
2003	350,004	4,532	0	58,353	90,847	0										
2004	363,800	13,304	0													
2005	355,091															
2006	366,497															
2007	361,091															

Table 8.– Chignik Lake sockeye salmon brood table after changes made in 2001.

Year	Parent Escapement	0.2	1.1	0.3	1.2	2.1	1.3	2.2	0.4	1.4	2.3	3.2	2.4	3.3	Other	Total
1915		0	0	0	0	0	0	0	0	0	0	0	4,514	4,514	0	9,028
1916		0	0	0	0	0	0	0	0	11,874	690,450	9,120	2,007	0	0	713,451
1917		0	0	0	0	0	339,637	149,163	0	296	274,036	0	0	0	0	763,132
1918		0	0	0	44,358	0	201,318	195,611	0	0	999,888	0	2,948	2,966	0	1,447,089
1919		0	0	0	100,404	2,425	243,024	286,119	0	2,492	423,094	8,270	0	5,828	0	1,071,656
1920		0	0	0	148,914	0	435,826	137,704	0	2,509	300,319	20,713	0	1,567	0	1,047,552
1921		0	0	0	101,251	0	216,728	278,711	0	4,085	193,620	2,245	955	3,396	0	800,991
1922	352,807	0	0	0	43,667	0	382,956	73,351	0	0	991,979	14,972	2,886	4,175	0	1,513,986
1923	213,781	0	0	0	74,884	218	410,194	245,187	0	2,360	577,390	1,111	1,647	2,376	0	1,315,367
1924	910,521	0	0	0	126,685	1,819	1,003,422	8,350	0	1,115	102,217	5,830	425	55	0	1,249,918
1925	677,566	0	0	0	3,736	0	51,222	195,414	0	332	427,580	7,817	5,367	456	0	691,924
1926	695,314	0	0	0	25,764	919	279,018	304,619	0	3,461	879,220	3,821	55	2,246	0	1,499,123
1927	429,525	0	207	0	113,952	1,499	951,950	100,633	0	744	203,942	1,586	1,225	5,557	0	1,381,295
1928	1,020,520	0	0	0	40,063	0	353,506	77,224	0	12,047	300,603	3,129	1,042	1,618	0	789,232
1929	914,307	0	0	0	16,254	0	584,561	38,873	0	5,675	361,557	1,165	2,192	1,251	0	1,011,528
1930	359,405	0	0	0	26,688	0	426,128	41,867	0	6,177	344,419	16,565	2,065	0	0	863,909
1931	631,986	0	0	0	30,856	2,454	296,899	138,440	0	3,747	264,858	0	2,678	635	0	740,567
1932	1,113,859	0	0	0	24,809	0	475,759	46,764	0	8,530	185,288	2,049	13,674	1,502	0	758,375
1933	310,088	0	0	0	35,679	0	311,946	35,705	0	48,795	321,467	0	1,267	301	0	755,160
1934	447,642	0	0	0	19,716	90	708,212	33,934	0	4,066	88,027	969	4,299	1,026	0	860,339
1935	462,469	0	69	0	37,642	308	148,352	16,893	0	13,842	299,288	3,284	4,082	976	0	524,736
1936	376,838	0	0	0	9,342	43	504,624	57,326	0	13,186	284,707	3,117	9,326	2,233	0	883,904
1937	406,618	0	33	0	31,723	145	480,250	54,435	0	30,220	651,642	7,116	2,664	639	0	1,258,867
1938	305,827	0	111	0	30,143	137	1,099,657	124,382	0	8,660	186,504	2,032	1,128	270	0	1,453,024
1939	512,754	0	106	0	68,919	315	314,851	35,542	0	3,674	79,035	859	5,420	1,305	0	510,026
1940	152,957	0	244	0	19,705	90	133,474	15,039	0	17,705	380,481	4,130	10,049	2,422	0	583,339
1941	531,904	0	70	0	8,342	38	642,782	72,293	0	32,912	706,532	7,654	2,225	537	0	1,473,385
1942	516,621	0	30	0	40,124	183	1,194,007	134,060	0	7,305	156,659	1,695	4,662	1,112	0	1,539,837
1943	1,205,418	0	143	0	74,442	340	264,830	29,686	0	15,007	324,527	3,562	5,405	1,321	0	719,263
1944	351,212	0	266	0	16,492	75	547,139	62,179	0	18,110	385,087	4,101	2,886	711	0	1,037,046
1945	151,326	0	59	0	34,405	157	652,782	72,138	0	9,784	207,054	2,186	1,246	315	0	980,126
1946	739,884	0	121	0	40,246	183	351,541	38,531	0	4,401	91,579	937	1,531	371	0	529,441
1947	1,393,990	0	147	0	21,549	98	156,343	16,644	0	5,048	108,068	1,165	1,316	333	0	310,711
1948	313,319	0	80	0	9,390	42	182,792	20,430	0	4,658	96,858	989	826	0	0	316,065
1949	574,715	0	36	0	11,360	52	165,402	17,581	0	1,766	103,345	0	496	650	0	300,688
1950	861,070	0	41	0	9,924	45	199,966	31,411	0	2,206	245,826	407	2,903	1,820	0	494,549
1951	490,899	0	38	0	33,082	0	618,729	13,748	0	7,046	242,042	0	1,028	0	0	915,713
1952	260,540	0	0	0	22,213	0	258,747	30,836	0	986	229,563	0	3,932	8,403	0	554,680
1953	221,408	0	0	0	9,167	428	125,399	32,350	0	470	396,916	1,935	934	5,424	0	573,023
1954	277,912	0	547	0	2,848	0	39,658	75,361	0	771	418,442	804	1,661	5,069	0	545,161
1955	201,409	0	369	0	32,187	0	303,988	32,708	0	168	363,162	1,252	0	0	0	733,834
1956	483,024	0	1,330	0	12,515	0	106,327	36,113	0	435	221,169	0	1,349	4,781	0	384,019
1957	328,779	0	0	0	17,746	622	232,393	109,475	0	351	332,661	2,104	1,189	1,319	0	697,861
1958	212,594	0	1,459	0	50,630	0	23,204	139,797	0	0	419,109	980	93	432	0	635,704
1959	308,645	0	3,286	0	18,094	907	109,204	81,669	0	117	197,975	738	689	187	0	412,866

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Table 8.– Page 2 of 2.

Year	Parent Escapement	0.2	1.1	0.3	1.2	2.1	1.3	2.2	0.4	1.4	2.3	3.2	2.4	3.3	Other	Total
1960	357,230	0	146	0	24,455	491	122,278	8,273	0	1,314	210,883	141	1,618	12,824	0	382,423
1961	254,970	0	718	0	1,899	799	109,935	18,702	0	220	401,732	2,698	5,335	2,420	0	544,458
1962	324,860	0	123	0	4,312	0	44,074	69,811	0	998	692,188	1,074	1,109	0	0	813,689
1963	200,314	0	0	0	5,536	1,300	103,116	68,605	0	29	243,939	0	1,529	883	0	424,937
1964	166,625	0	88	0	6,607	4,550	24,880	65,639	0	713	140,826	960	194	5,776	0	250,233
1965	163,151	0	1,636	0	25,157	5,547	162,041	59,008	0	361	614,235	971	650	94,754	0	964,359
1966	183,525	0	1,715	0	14,784	942	284,131	28,590	0	455	407,967	2,419	0	16,843	0	757,845
1967	189,000	0	510	0	5,845	726	77,202	30,658	0	653	449,694	2,591	1,305	0	0	569,183
1968	244,836	0	863	0	3,781	0	107,955	19,044	0	619	567,425	15,173	2,470	27,620	0	744,949
1969	132,055	0	0	0	1,155	990	82,718	263,494	0	751	447,727	6,689	0	15,060	0	818,583
1970	119,952	0	0	0	17,731	11,703	25,375	138,675	0	1,187	415,418	10,992	0	17,763	0	638,845
1971	232,501	0	1,458	0	14,179	11,583	167,089	369,810	0	211	1,697,096	3,662	3,205	15,662	0	2,283,954
1972	231,270	0	0	0	27,096	2,202	107,848	85,981	0	111	810,308	34,712	250	3,456	0	1,071,963
1973	243,729	0	0	0	5,165	9,601	63,986	195,139	0	0	859,539	3,600	1,354	5,159	0	1,143,543
1974	313,343	0	3,951	0	21,748	3,117	98,583	184,079	0	55	735,042	2,209	2,188	8,748	2,553	1,062,274
1975	257,508	0	0	0	22,942	6,658	134,113	201,103	0	863	811,950	3,375	6,436	2,329	7,594	1,197,363
1976	281,810	0	1,031	0	64,277	875	732,795	89,113	0	2,479	498,558	0	2,730	9	4,452	1,396,318
1977	328,916	0	273	0	49,867	3,755	155,162	59,867	0	1,715	1,057,588	0	2,850	1,106	10,476	1,342,658
1978	262,815	0	399	0	16,722	5,810	227,692	279,023	0	961	390,267	687	1,668	168	228	923,623
1979	246,349	0	2,025	0	90,196	4,429	394,998	39,406	0	1,176	264,856	369	1,442	769	3,163	802,829
1980	294,481	0	1,571	11,611	18,519	8,491	149,295	305,514	0	620	439,791	3,038	756	974	1,082	941,262
1981	261,239	0	1,564	0	84,701	4,848	227,684	72,940	0	604	337,180	137	594	68	32	730,352
1982	305,193	0	2,420	0	50,521	3,139	177,018	98,754	0	677	533,173	146	1,269	0	276	867,394
1983	428,034	0	0	2,471	11,037	3,481	135,504	100,439	0	191	1,014,238	740	11,053	72	0	1,279,226
1984	267,861	109	832	505	27,815	9,809	137,789	297,259	0	2,359	1,558,686	1,658	8,876	6,550	547	2,052,793
1985	372,798	90	630	190	17,099	15,044	165,757	154,043	0	6,117	459,442	1,063	3,827	3,526	161	826,989
1986	215,547	94	2,518	12,421	170,342	305	316,570	161,091	0	1,707	463,238	7,247	11,927	1,988	573	1,150,022
1987	214,444	5,947	652	976	66,074	8,933	425,983	209,848	0	5,591	959,150	6,350	6,354	62,566	109	1,758,534
1988	255,177	0	2,225	1,038	53,583	3,095	273,248	101,364	0	1,846	179,809	3,556	9,433	7,838	1,129	638,164
1989	557,174	389	7,425	8,550	158,189	4,415	238,293	91,912	0	3,551	1,070,406	6,596	11,103	85,361	308	1,686,496
1990	335,860	413	409	5,271	22,662	1,151	326,230	166,352	0	1,873	446,003	1,731	2,016	15,270	827	990,206
1991	377,438	117	175	898	93,587	1,722	286,297	104,860	0	603	446,211	2,746	4,936	3,986	3,767	949,904
1992	403,755	559	986	21,610	17,908	12,056	203,800	190,144	0	2,232	524,930	57,442	1,069	20,705	379	1,053,820
1993	333,116	456	481	4,023	29,686	17,852	134,040	311,581	0	2,070	1,020,180	4,795	1,065	62	155	1,526,445
1994	197,444	79	886	0	55,525	7,069	451,141	292,046	0	3,212	401,872	248	2,258	1,921	226	1,216,483
1995	373,425	358	1,454	5,628	183,410	0	320,493	30,763	0	3,907	771,267	4,314	10,290	11,436	381	1,343,702
1996	284,389	979	55	41,569	42,153	105	740,974	40,140	0	7,531	503,463	3,571	3,846	7,301	0	1,391,686
1997	378,950	2,829	155	3,189	35,303	1,848	211,833	94,455	0	1,984	659,766	2,426	3,779	2,789	0	1,020,355
1998	290,469	173	1,788	2,342	63,671	133	205,444	51,079	0	443	161,661	460	277	592	218	488,281
1999	258,542	699	66	8,477	42,692	2,139	131,351	39,710	0	1,974	111,636	109	2,265	1,554	0	342,671
2000	269,084	246	829	3,725	59,500	1,669	551,058	17,973	0	10,263	463,675	0	11,913	2,729	0	1,123,580
2001	392,905	0	316	13,049	13,614	922	383,305	48,615	1,608	22,155	441,534	482				
2002	344,519	0	394	11,402	36,890	0	350,418	28,709	1,130							
2003	334,119	816	804	20,583	61,186	241										
2004	214,459	8,236	530													
2005	225,366															
2006	368,996															
2007	293,883															

Table 9.– Historical Chignik early- and late-run sockeye salmon escapements estimated by the SPA and July 4th cut-off run apportionment methods.

	Method of Estimated Escapement			
	July 4th Method		SPA	
Year	Early Run	Late Run	Early Run	Late Run
1980	378,158	285,903	369,580	294,481
1981	687,964	143,485	570,210	261,239
1982	598,655	239,007	616,117	305,193
1983	438,364	415,848	426,178	428,034
1984	479,451	386,123	597,713	267,861
1985	405,991	339,847	373,040	372,798
1986	444,501	328,818	557,772	215,547
1987	441,911	361,832	589,299	214,444
1988	435,399	240,358	420,580	255,177
1989	425,295	515,880	384,001	557,174
1990	406,820	363,590	434,550	335,860
1991	679,447	360,651	662,660	377,438
1992	396,025	368,411	360,681	403,755
1993	403,982	293,395	364,261	333,116
1994	666,706	300,203	769,465	197,444
1995	449,895	290,025	366,495	373,425
1996	420,488	328,649	464,748	284,389
1997	420,252	355,366	396,668	378,950
1998	481,619	219,509	410,659	290,469
1999	420,170	295,796	457,424	258,542
2000	392,518	412,707	536,141	269,084
2001	851,455	285,463	744,013	392,905
2002	394,278	330,942	380,701	344,519

Table 10.– Statistical comparisons of variances and means for historical Chignik early- and late-run sockeye salmon escapements estimated by the SPA and July 4th cut-off run apportionment methods.

Comparison	Run	Critical Value	F or *t* statistic
F-test for sample variances	Early	2.084	0.956
	Late	2.084	0.627
t-test for sample means	Early	0.480	-0.140
	Late	0.480	0.218

FIGURES

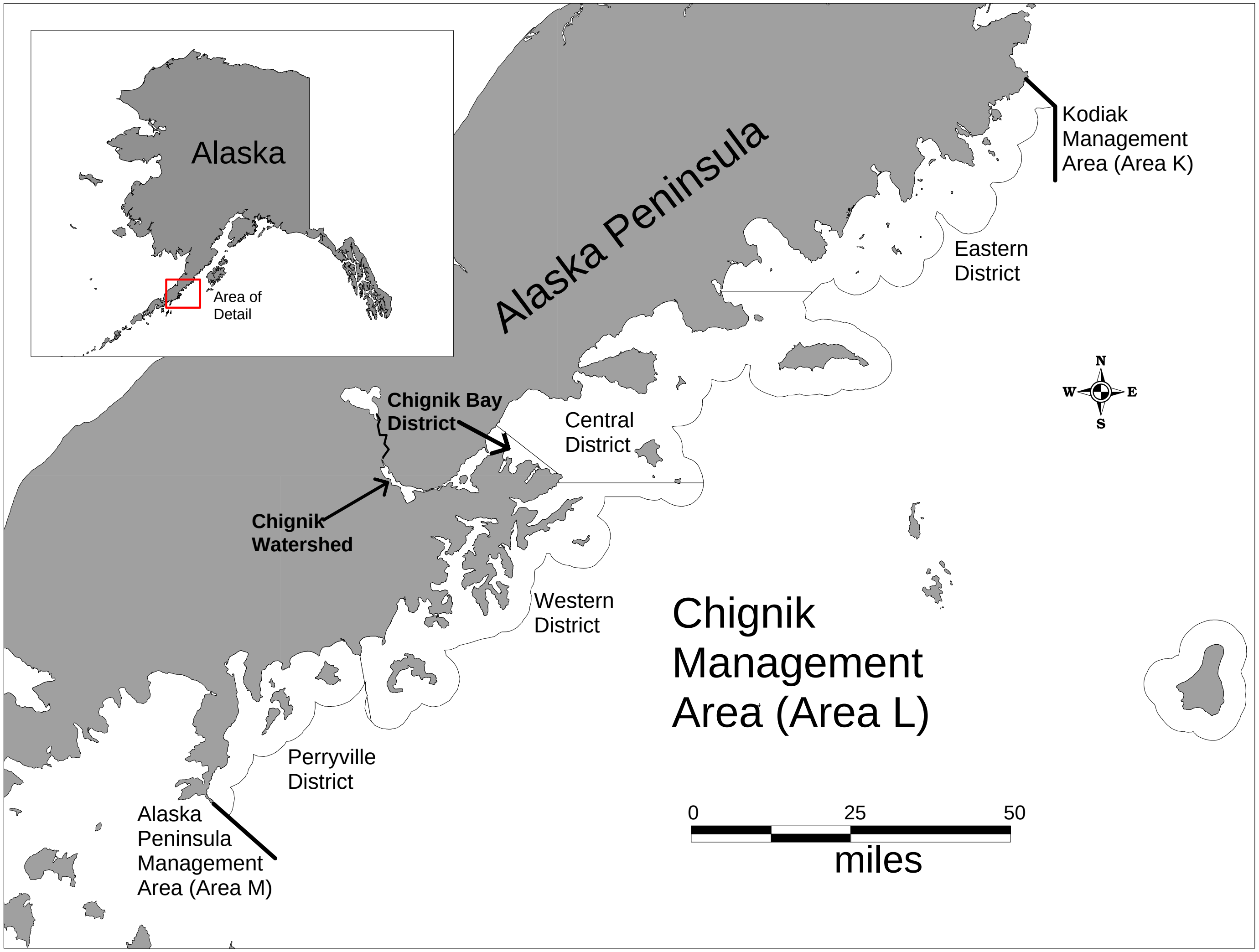

Figure 1.– Map of the Chignik Management Area for commercial salmon fishing.

APPENDIX A: WESTWARD REGION SALMON SCALE SAMPLING POLICY

Appendix A1.– Westward Region salmon scale sampling policy.

ALASKA DEPARTMENT OF FISH AND GAME

DIVISION OF COMMERCIAL FISHERIES

MEMORANDUM

TO:	Denby S. Lloyd Regional Supervisor Division of Commercial Fisheries Region IV - Kodiak	DATE: PHONE: FAX:	March 4, 2002 (907) 486-1855 (907) 486-1841
THROUGH:	Patricia A. Nelson Regional Finfish Research Supervisor Division of Commercial Fisheries Region IV - Kodiak	SUBJECT:	Westward Region Salmon Scale Sampling Review
FROM:	Mark J. Witteveen Finfish Research Biologist Division of Commercial Fisheries Region IV - Kodiak		

Denby,

On February 27 and 28, Patti, Ken, and I met separately with the Kodiak, Chignik, and Peninsula management biologists to discuss the current catch and escapement sampling goals and objectives. To try to evaluate the utility of particular catch samples, we measured them against five criteria that would aid in management of the fishery. Specifically, we looked at each catch sample to see if it is used or could be used to do one or more of the following:

1. Develop brood tables to evaluate long term production and forecasting;
2. Identify temporal shifts (within year) in age composition of a mixed stock catch;
3. Identify temporal shifts (between years) in age composition of a mixed stock catch;
4. Recognize specific stocks within a mixed stock catch when age markers are present;
5. Determine stock composition estimates using scale pattern analysis (SPA).

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Escapement samples were also discussed, specifically whether they were going to be taken during the 2002 season and whether the sample goals were appropriate. Each discussion resulted in recommendations for varying degrees of change. These modifications, per your approval, will be implemented during the 2002 season and many will be reevaluated prior to the 2003 season.

The recommendations and discussion of each group are presented below:

Kodiak

In the Kodiak meeting, each catch sampling goal was evaluated against the previously mentioned criteria and it was determined that the following samples did not meet any of the criteria, were not being utilized for any specific purpose and should not be sampled during 2002:

1. **Eastside Kodiak District-** Sitkalidak Section
2. **Mainland District** – North Shelikof
3. **Mainland District** – Katmai/Alinchak
4. **Mainland District** – Cape Igvak Section (early)
5. **Mainland District –** Cape Igvak Section (late)

Despite stakeholder interest in age composition information from the Cape Igvak fishery, recent department analyses of the utility of scale sampling for stock identification in the Cape Igvak area suggests that age composition alone is limited to determining whether “other” stocks are present. Neither the proportion of the stocks in the catch nor the origin of the “other” stocks can be determined. Given this limited qualitative information, it was determined that with limited budgets, the Cape Igvak sampling should be terminated.

Other minor catch sampling modifications included the addition of targeted sampling of the new Malina Bay Terminal Harvest Area (THA). A request was also made to increase effort toward age composition determination of the Alitak Bay Test fishery catch and its comparison to Upper Station escapement prior to June 5. Efforts will be made to accomplish this during the 2002 season.

Minor changes were also made to escapement sampling. Portage Lake sockeye salmon escapements will not be sampled during the upcoming season due to the completion of the project at Portage Lake. During the 2002 season, an increased effort, perhaps through the use of a Kodiak National Wildlife Refuge volunteer, will be made to sample the early and late Akalura sockeye salmon escapements. Afognak Lake (Litnik) sockeye salmon escapement sampling goals were changed from 480 every two weeks to the more standard 240 per week. Efforts by sportfish staff, with help as needed from Kodiak research staff will be made to increase sockeye salmon escapement sampling at Saltery River for the 2002 season. The goal is to obtain a biweekly sample with the sample goal to be calculated this spring. Ideally, this will allow for brood table development and forecasting.

Different approaches to improve escapement sampling quality and effort were discussed and it was determined that a preseason meeting with all weir staff was necessary. More frequent visits to field camps by management and research staff will also be attempted during 2002 to provide training and further establish the importance of sampling.

To more effectively track the progress of sampling goals being attained, the catch sampling crew will be informed of each field camp’s sampling goal and will inform management staff if, and when, goals are not being met.

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Chignik

The focus of discussion with the Chignik management staff centered around sockeye salmon sampling in the outside districts (Eastern, Central, Western, and Perryville Districts) and escapement sampling using a weir trap. The outside districts catch samples were compared against the five criteria and it was determined that they did not effectively meet any of the requirements. Similar to the Cape Igvak samples, the outside districts samples were useful only for determining presence of “other” stocks, but were not useful in determining individual stock proportion or identification. A consensus was reached that the outside districts sampling should be terminated due to its limited utility and funding.

Due to several uncertainties, it was determined that the weir trap sampling should be used as a pilot project during the 2002 season. Some concern was expressed about the relative behavior of the Black Lake run versus the Chignik Lake run. Observations made by local residents and department staff indicate that the Chignik Lake run is more aggressive (i.e., they jump more and hold in the lagoon for a shorter time). Concern was expressed at the possibility that one run versus the other may enter the weir trap more quickly thereby introducing bias in the sampling. This could be tested by comparing trap-caught age compositions with those caught with a beach seine behind the weir during the overlap period.

Further, while it is assumed that there would be no differences between Chignik Lagoon seine caught fish and those sampled at the weir, this assumption has not been recently tested. A comparison of Chignik Lagoon caught fish with those caught at the weir the following day will be made during the 2002 season during the early and late run to ensure that no bias is introduced by weir sampling.

For the most part, sampling for SPA stock separation at Chignik will be the same as previous years with most, or all, of it occurring through catch sampling and test fishery sampling. The previously mentioned studies may allow the weir trap caught fish to replace catch samples in subsequent seasons. The increased effort required for the increased sampling should be offset if a research FB I for SPA is hired.

Alaska Peninsula

Discussion of catch samples collected from Sand Point focused around the utility of the Southeastern District Mainland (SEDM) and Shumagin Islands sockeye salmon catch samples. Both of these samples were determined to be similar to the Cape Igvak and Chignik outer districts samples in their limited utility and the fact that they do not meet any of the criteria. The SEDM samples have historically been logistically difficult to collect and usually involve additional line 100 funds due to sea duty premium pay. Research staff determined that it was no longer able to contribute funds to the collection of these samples, but management staff indicated that they did not want to terminate the sampling so that a historical database would be maintained. Since the SEDM samples are typically available at the Sand Point dock only once or twice per year, it was determined that these would not be collected; however, the Shumagin Island, samples will continue to be taken using existing management funds.

It was determined that all of the North Peninsula sockeye salmon samples met one or more of the criteria and sampling would be retained. Further, a subsample of lengths and sex will be added to the sampling protocol for Nelson Lagoon and Harbor-Strogonof samples. This subsampling will not require additional funds. While the coho, chinook, and chum samples from Nelson Lagoon and Harbor-Strogonof areas do not meet any of the criteria, they are used in a limited

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capacity to explore age class abundance as an indicator of subsequent years' abundance. A request was made by management staff for research staff to explore the possibility of expanding the use of chum, coho, and chinook samples on the North Peninsula. More specifically, research staff will perform exploratory data analyses on the historical database to evaluate the usefulness of these data throughout the next year.

Escapement sampling on the Alaska Peninsula was discussed and it was determined that no changes were necessary or desired. A possible review of Bear River sockeye salmon escapement goals and the work required to accomplish the review was discussed. Continuing limnology work along with a more comprehensive review of available spawning habitat should provide the data needed to determine if the current escapement goals are appropriate. Research staff will work toward this goal in the coming years.

cc: Bouwens, Brennan, Wadle, Burkey, Dinnocenzo, Shaul, Murphy, Schrof, Honnold, Sagalkin, Pappas, Daigneault.

APPENDIX B: CHIGNIK AREA SOCKEYE SALMON RUN RECALCULATION MEMORANDUM

Appendix B1.– Chignik Area sockeye salmon run recalculation memorandum.

ALASKA DEPARTMENT OF FISH AND GAME

DIVISION OF COMMERCIAL FISHERIES

MEMORANDUM

TO:	George Pappas Chignik Management Area Manager, FBIII Division of Commercial Fisheries Region IV - Kodiak	DATE: PHONE: FAX:	December 13, 2001 (907) 486-1806 (907) 486-1841
FROM:	Michael Daigneault Chignik Management Area Asst. Manager Division of Commercial Fisheries Region IV – Kodiak	SUBJECT:	Run Recalculation, 1973-99

The following information describes the rational and methods for recalculating Black Lake and Chignik Lake sockeye escapement, catch, and total run numbers from 1973-99.

In preparing BOF reports and AMRs, it was discovered that BOF Table 6/AMR Table 34 had considerable inconsistencies in how catch and potentially escapement were applied to run apportionment percentages to calculate total run numbers for each run. The most significant problem with the table is that Igvak and SEDM catch post July 25 was applied to the Chignik catch numbers and apportioned between Black and Chignik Lake, most of which applied to the Chignik Lake run. Another inconsistency in the table is that different travel times to Chignik Lagoon have been used annually from areas within the CMA and adjacent areas (Igvak, SEDM) along with travel time from the lagoon to the Chignik Weir.

Escapement data for 1973-90 were obtained from daily weir counts published in the AMRs while escapement data for 1991-99 were obtained from the Alaska Peninsula Weir Report. Travel time from the lagoon to the weir was assumed to be 1 day.

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Catch numbers for 1973-1999 were obtained from the fish ticket database. The following catch numbers and travel times to the lagoon were used in the recalculation:

- 80% Igvak catch through July 25 (5 days)
- 80% SEDM catch through July 25 (actual stat areas varied from year to year based on regulation changes [5 days])
- Chignik Lagoon catch for the entire season
- Chignik/Hook/Kujulik Bays for the entire season (1 day)
- Cape Kumlik/South Aniakchak and Western District (2 days)
- Eastern District and Perryville District (3 days)

Escapement and catch data, adjusted to Chignik Lagoon date, were multiplied by the available stock separation percentages published in the AMRs. From 1973-81, the only stock separation data available is the early and late run age composition data by sampling period. Sampling periods usually ranged from 1 day to 2 weeks, but typically were 2-6 days long, with shorter sampling periods during the run transition period. The total number of fish apportioned to each run during a sample period was summed, then divided by the total run for that sample period to obtain stock separation percentages for the sample period. Thus, the daily stock separation percentages were identical over the sample period and then would often change substantially from one time period to the next. This method has the potential of both overestimating and underestimating the individual run escapement and catch based on static stock separation percentages over sample periods. However, the magnitude of these over- and underestimates can vary among sample periods and years based on the actual catch and escapement numbers recorded on any given day. No stock separation data were available in the 1982 AMR, therefore, escapement, catch, and total run were not recalculated for 1982. From 1983-99, daily escapement and catch estimates for each run obtained from postseason scale pattern analysis was summed then divided by the total run for that day to obtain daily stock separation percentages.

The calculated stock separation percentages were multiplied by the daily escapement and adjusted catch numbers to obtain daily catch and escapement numbers for each run. The daily numbers were summed for each run to obtain the new season totals, which were inserted into the aforementioned tables.

The file with all run recalculations is available for scrutiny at G:\alluse\miked\histrunpart_recalc.xls. The catch numbers are located in two separate files: Igvak/SEDM catch is located at G:\alluse\miked\HISTCHGIGSTEP.xls and the partitioned Chignik catch is located at G:\alluse\miked\732001CHIGNIK.xls.

Attached is a new and old version of the BOF/AMR table with significant changes (ie >5,000 fish) to the previously reported numbers highlighted along with the resulting net change in the total run.

cc. Campbell, Nelson, Lloyd, Witteveen, Bouwens,Vining

APPENDIX C: MEMORANDUM DETAILING CHANGES IN THE CHIGNIK RIVER WATERSHED RUN APPORTIONMENT METHODS

Appendix C1.– Memorandum detailing changes in the Chignik river watershed run apportionment methods.

ALASKA DEPARTMENT OF FISH AND GAME

DIVISION OF COMMERCIAL FISHERIES

MEMORANDUM

TO:	Denby S. Lloyd Regional Supervisor Division of Commercial Fisheries Region IV - Kodiak	DATE: PHONE: FAX:	May 28, 2004 (907) 486-1855 (907) 486-1841
THRU:	Patricia Nelson Regional Finfish Research Supervisor and Jim McCullough Regional Finfish Management Supervisor Division of Commercial Fisheries Region IV - Kodiak	SUBJECT:	Chignik River inseason run apportionment
FROM:	Mark Witteveen Regional Finfish Research Biologist Division of Commercial Fisheries Region IV - Kodiak		

Introduction

Commercial fisheries management of the sockeye salmon returning to the Chignik River watershed is complicated by two distinctly timed runs. The “early” run that returns to Black Lake and its tributaries begins in late May, peaks during late June, and continues through July. The “late” run that returns to Chignik Lake and its tributaries begins in earnest in late June, peaks in late July and continues through September and October. Commercial fishing time for sockeye salmon is regulated to achieve interim escapement objectives by specific dates for each run.

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Therefore, some method for estimating the contribution of each run to the escapement is required, particularly during the overlap period (late June through early July) when both runs are present in significant numbers.

From 1983 through 2003, scale pattern analysis (SPA) models were used to estimate the contribution of each run inseason through the development of proportional time of entry curves to aid in management decisions. The SPA models were based on studies by Conrad (1983 and 1984). The models were based on differences in measurements of the freshwater scale growth characteristics of each run. The models established a set of criteria by which the measurements of scale growth from a fish of unknown origin were classified as being more similar to the scale measurements from the early run or the late run fish (Witteveen and Botz 2003). The SPA models were developed inseason for management of the fishery and were refined postseason when more accurate scale measurements became available.

Because SPA models were developed inseason and measured the proportion of Chignik and Black Lake fish present, a significant amount of Chignik Lake (late run) salmon had to be present to evaluate whether the model was performing correctly. Thus, samples had to be classified by the model well into the overlap period between the runs (late June through early July) before the model could be relied upon for management decisions. Prior to the model being finalized, all escapement through the weir was assigned to Black Lake (Pappas 2003). When the model was finalized, the estimated cumulative escapements to Black Lake and Chignik Lake were recalculated based on the stock contribution estimates generated from the model coupled with a logistic proportional time of entry curve. Decisions to open or close the commercial fishery were then based on those escapement estimates meeting the interim escapement objectives.

One of the problems with the process was that the delay in finalizing the model, until approximately the first week in July, resulted in a time period during early July when the department was unsure of the proportions of each run and management decisions were often made with little information about escapement by stock.

Management emphasis usually shifted from the Black Lake run to the Chignik Lake run after the date, according to the SPA model, when the proportion of Black Lake fish in the run was equal to the proportion of Chignik Lake fish. This date was often referred to as the 50/50 date since it was when Black Lake sockeye salmon composed 50% of the daily run and Chignik Lake sockeye salmon compose 50% of the daily run (Figure 1; Point A). Since the Black and Chignik Lake runs are different in size and timing, the 50/50 date was often not the same as the halfway point of the overlap between the two runs.

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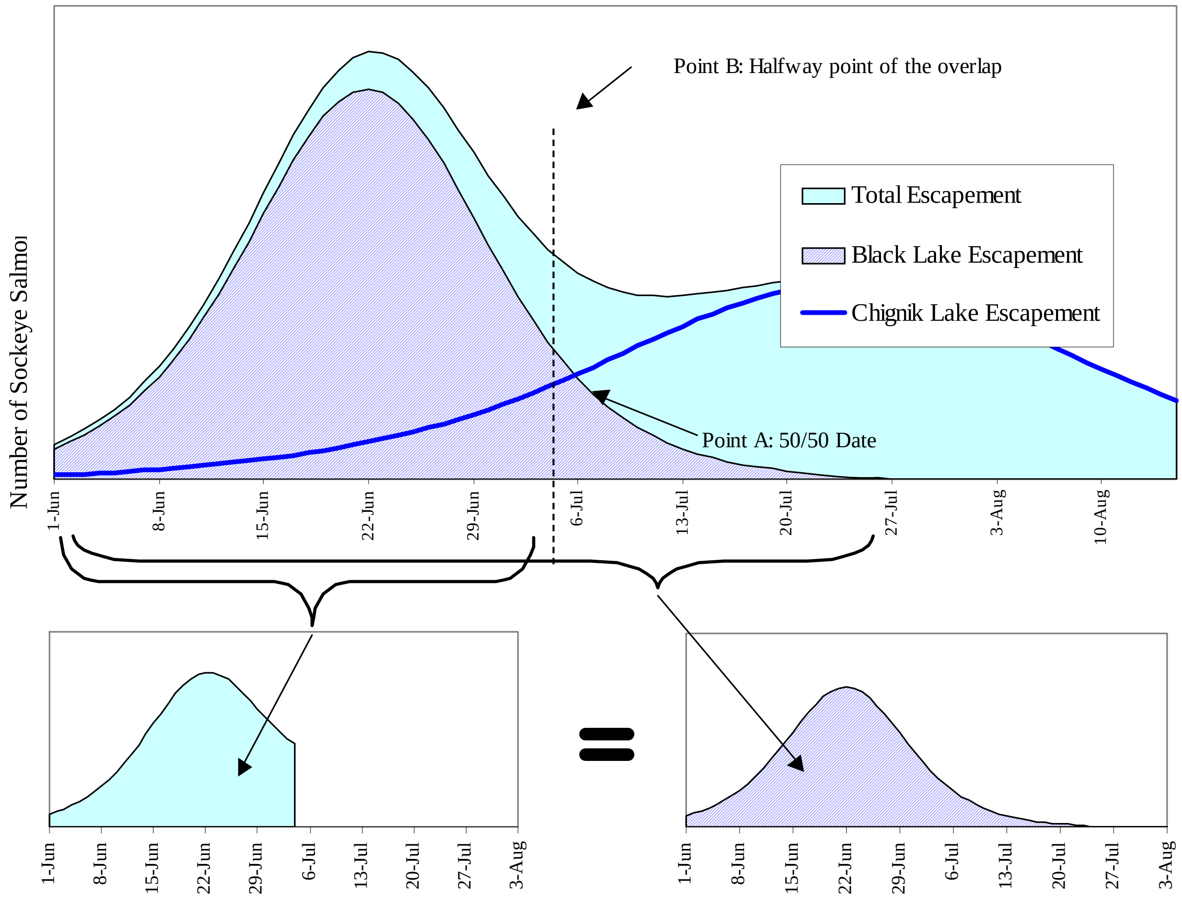

Figure 1. Black Lake, Chignik Lake, and total sockeye salmon escapement and a visual representation of how the total escapement through a fixed date approximates the total Black Lake escapement.

The halfway point of the overlap between the runs is the date at which the total number of Chignik Lake sockeye salmon that have escaped is equal to the number of Black Lake fish that will escape (Figure 1; Point B). Since those two escapements are equal, they balance each other out and therefore, the total escapement on that date is an approximation of the total Black Lake escapement. For example, the commercial fishery manager regulates the fishery so that a cumulative escapement count of 350,000 sockeye salmon is reached on the date corresponding to the halfway point of the overlap (Figure 1; Point B; July 4 for explanation purposes), postseason SPA results would assign some of the escapement prior to July 4 to the Chignik Lake run. Since July 4 is the halfway point of the overlap in this example however, postseason SPA would also

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assign the escapement so that the number of Black Lake early run fish that escape after July 4 would be equal to the number of Chignik Lake fish that escaped before July 4. The two estimates would essentially balance each other out and the result would be a postseason escapement estimate of 350,000 Black Lake fish.

The termination of the Chignik SPA project, due to budget cuts, has necessitated an evaluation of alternative methods that could be used inseason to estimate the Black and Chignik Lakes runs. This memorandum presents the estimated error associated with the SPA postseason estimates generated in 2003. In addition, several alternative inseason run separation methods are presented and subsequent run estimates are compared to the estimates generated by postseason SPA. Finally we present a recommendation, based on our evaluation, of the method we believe to be the best alternative to SPA

Methods

Postseason SPA

Postseason SPA has been conducted annually to assign the Chignik weir sockeye salmon escapement and Chignik Management Area (CMA) sockeye salmon harvest to the early or late run. Since scale samples from the entire season can be used in the postseason SPA, it is inherently more accurate than the inseason SPA and currently provides the best known estimates of the Chignik and Black Lake runs.

Postseason SPA Error

Estimating the error around the SPA generated estimates is essential for providing a meaningful comparison to the alternative run separation methods currently being investigated. Typically, the overall error associated with SPA is not calculated due to the difficulty in estimating the multiple sources of the error from aging, sampling, and the discriminant analysis calculations. Further error is associated with the smoothing curve function applied to the SPA results. In an effort to get some idea of the variability surrounding the postseason SPA estimates, the error associated with the discriminant analysis calculations and the smoothing curves were estimated for 2003. The 2003 postseason SPA estimates were selected because the discriminant analyses had high resubstitution accuracies and the smoothing curves fit the data well. As a result, the relative error associated with the 2003 model likely represents a “best case” scenario for the relative error associated with the postseason SPA estimates, to use for comparison purposes.

The most current method used to estimate daily escapement to Black and Chignik Lakes postseason included fitting the results from the age 1.3 and age 2.3 SPA discriminant analysis models to two separate logistic curves to provide a daily estimate of stock composition for those age classes. These two age classes combined comprise 77.6% of the Chignik Lakes run (1994 through 2003 average). Age 1.3 sockeye salmon dominate the early run, while age 2.3 sockeye salmon dominate the late run. The discriminant analysis output provides a point estimate as well as the 90% upper and lower confidence bounds for each sample. The logistic function was used to fit a curve to the upper confidence bounds from each age 1.3 sample to provide a daily estimate of the upper error bound associated with the discriminant analysis. The upper bound

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was further expanded by estimating a 90% upper confidence bound for the logistic function fit to the discriminant analysis upper bounds thereby providing a daily estimate of the upper 90% confidence bound accounting for error associated with the discriminant analysis and fitting of the data to the logistic curve. This procedure was repeated for the lower bound for age 1.3 samples and to the upper and lower bounds for age 2.3 samples. The upper and lower bounds for each curve and age class were integrated into the daily escapement and daily age composition estimates to estimate a daily upper and lower bound for the escapement attributed to Black Lake and Chignik Lake as described in Witteveen and Botz (2003). The daily escapements from the upper and lower bounds for each run were then summed to provide an overall upper and lower escapement bound for each run.

Inseason Estimates

Several approaches were explored to develop a viable alternative inseason method of separating the runs, and each approach was compared to the escapements of each run estimated from the postseason SPA proportional time of entry curves, under the assumption that these are the most accurate estimates. Points along the proportional time of entry curve for the Chignik runs are expressed as the daily proportion of the total Chignik daily escapement attributable to the Chignik Lake stock. Since the Chignik Lake stock is often assumed to compose 100% of the run by July 31, the curve terminates on that date; however, the Chignik Lake run generally continues into September and October. Reliable age composition estimates were available for 1986 through 2003, so those years were used for most comparisons. The inseason SPA method was also included in the analyses to provide a point of comparison to the current inseason methodology. Each method's deviation from the postseason SPA estimates was measured for accuracy using the average difference between the estimate provided by the method being measured and the postseason SPA estimate (1986 through 2003). Each method was also measured for precision using the squared average difference between the estimate provided by the method being measured and the postseason SPA estimate (1986 through 2003). For the purposes of this study, accuracy is considered a measure of the deviation from the actual value (estimated by postseason SPA) and can be used to determine if a method is biased to over-or underestimate the actual estimate. An average difference closer to zero would indicate higher accuracy and a positive value would indicate a tendency to overestimate, while a negative value would indicate a tendency to underestimate. Precision, in this case, is a measure of consistency and a lower average squared difference would indicate higher precision.

Inseason SPA

The inseason SPA proportional time of entry curve has historically been used inseason each year to estimate Black Lake and Chignik Lake escapement from 1983 through 2003; however, these data were only available for 1988 through 2003. The methods used to determine these estimates are summarized in Witteveen and Botz (2003). In general, SPA models, coupled with a smoothing curve provide an estimate of the daily proportion of fish that are bound for the Black Lake and Chignik Lake runs. Typically, the Chignik Lake run is assumed to compose 100% of the escapement beginning on August 1 for inseason analysis. In recent years however, and during

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years in which the timing has appeared to be extremely early or late, the proportional time of entry curve was not forced to be 100% on August 1. Examining the daily proportion throughout the summer results in a proportional time of entry curve of the Chignik run attributable to the Chignik Lake stock which can be applied to daily escapement and catches to estimate the total run of each stock (e.g., Figure 2).

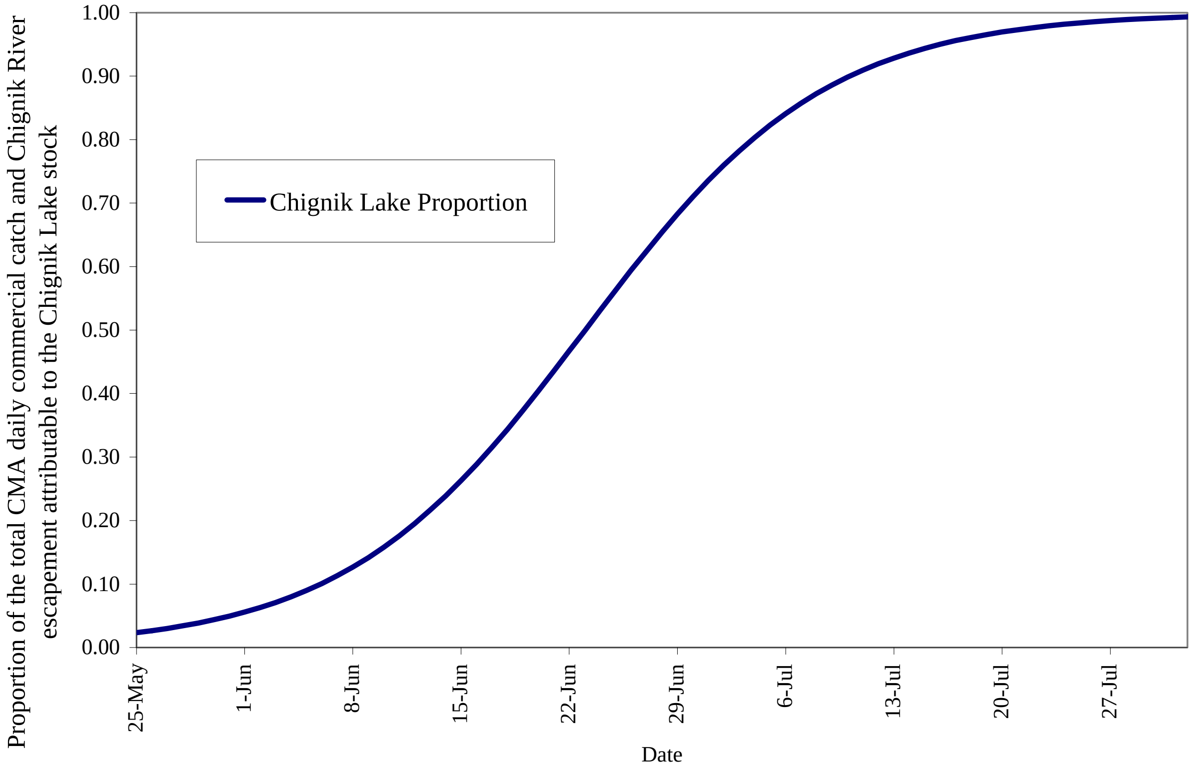

Figure 2. A typical Chignik River watershed proportional time of entry curve for the Chignik Lake stock.

The total escapement estimated for each year (1988 through 2003) using the inseason SPA time of entry curve was compared with the total escapement estimate from the postseason SPA time of entry curve to evaluate how accurate and precise the current inseason method was for comparison to alternative inseason methods.

Average SPA

The average SPA proportional time of entry curve was derived by examining a given day and averaging the proportion of the total Chignik escapement attributable to the Chignik Lake stock

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from the same day from all postseason SPA proportional time of entry curves available (1983 through 2003; Figure 3). This procedure was repeated for each day from May 25 through the end of the season to arrive at an overall proportional time of entry curve that represented an average of the previous SPA curves. The average SPA proportional time of entry curve was then applied to the daily escapement for each season (1986 through 2003) to calculate the Black Lake and Chignik Lake escapement estimates in each year. Those escapement estimates were then compared with the escapement estimates derived from the postseason SPA estimates that were generated each year. The purpose of the comparison was to evaluate the accuracy and precision of using the same average SPA proportional time of entry curve to estimate the proportion of the total run composed of Chignik Lake fish by day for all years.

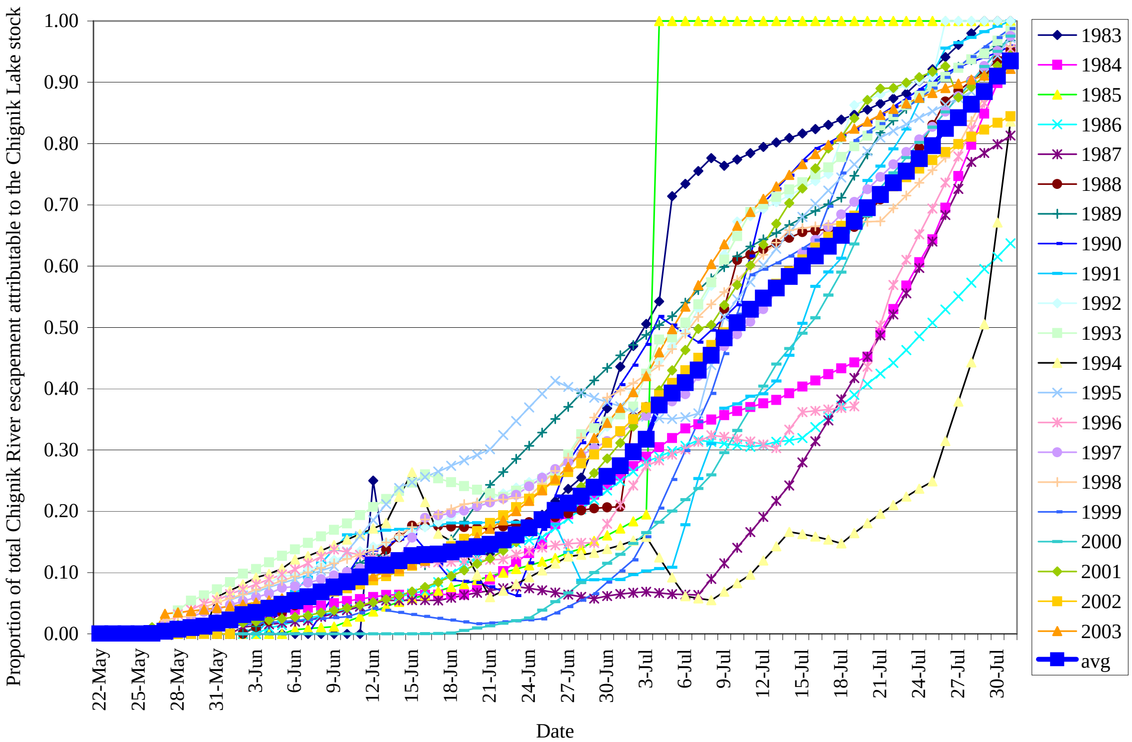

Figure 3. The proportional time of entry curves from postseason SPA depicting the daily proportion of the Chignik run attributable to the Chignik Lake stock, 1983-2003 with the average curve depicted.

Logistic curves

The proportional time of entry curves, developed using postseason SPA (1986 through 2003) were examined and two groupings, based on observed differences in run timing, were apparent from the curves. One set of years (1988, 1989, 1990, 1992, 1993, 1995, 1997, 1998, 2001, 2002, and 2003) seemed to have an earlier run timing while a second group (1987, 1991, 1996, 1999, 2000) seemed to have a later run timing. Two logistic model curves were then fit to represent the two groups. The 1986 and 1994 data were excluded because the age composition estimates did not appear to be reliable and the SPA model did not appear to work well during these years. The daily proportions estimated by the curves were then applied to the daily escapement from the appropriate years to estimate Black Lake and Chignik Lake escapement for each year, 1987 through 2003, excluding 1994. The proportion of Chignik Lake fish by day and year was given equal weight; therefore, the resultant curves were not biased by years with larger sample sizes or larger run sizes. Average air temperature in Cold Bay and age composition trends seemed to be good predictors of which curve (early or late) should be applied in a given year.

Age transition

The age transition date is the date at which the dominance in age composition switches from age 1.3 fish (generally Black Lake run) to age 2.3 fish (generally Chignik Lake run; 2003 season illustrated in Figure 4).

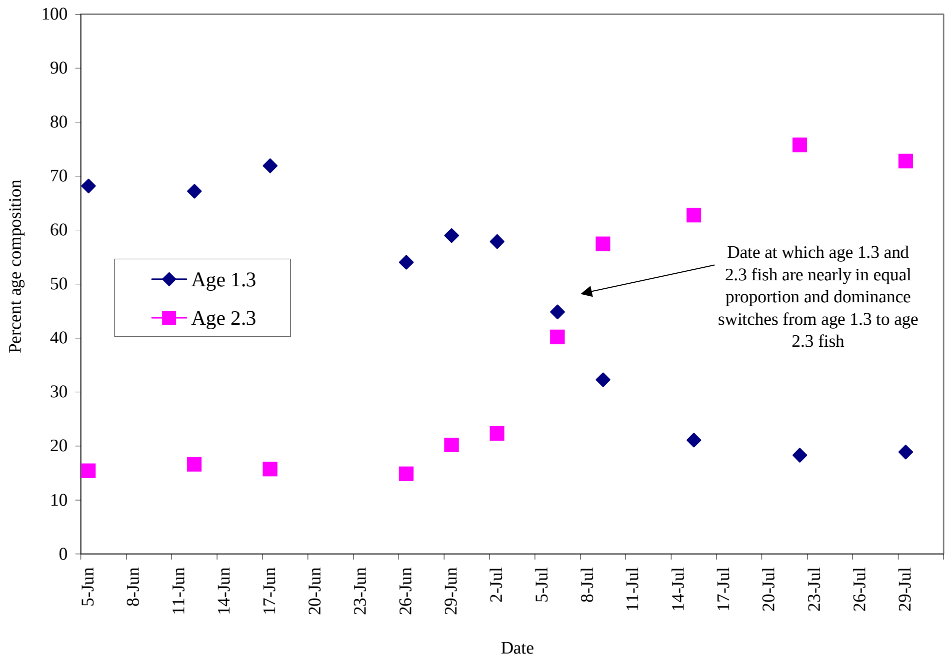

Figure 4. The estimated age composition of Chignik Lagoon age 1.3 and 2.3 fish by day throughout the 2003 season with the age transition date depicted.

To estimate the early and late-run escapements, the age transition date was considered to be the date at which the Chignik Lake run becomes dominant. All escapement prior to that date was

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considered Black Lake and all escapement after that date was considered Chignik Lake for all years, 1986 through 2003. The resultant escapement estimates for each stock in each year were compared with the postseason SPA escapement estimates for each year to determine the accuracy and precision of this method.

Total escapement through a fixed date

To provide an unweighted estimate of the fixed date at which the total escapement most closely approximates the postseason SPA of Black Lake escapement (Figure 1; Point B), the daily escapement was examined. The date on which the total cumulative escapement was closest to the postseason SPA Black Lake escapement estimate was determined for each year, 1986 through 2003 (Figure 1). Those dates were then averaged across the years to estimate the best fixed date at which total escapement is closest to the postseason estimate of Black Lake escapement. Postseason SPA would clearly allocate some of the escapement prior to that fixed date to the Chignik Lake run and some of the escapement after that date to the Black Lake run, but the date was selected so that those allocations would be as similar as possible and balance each other out.

For the purposes of this analysis escapement through a date is considered to be the total escapement counted through the Chignik weir for that day through 11:59 PM.

Results

Postseason SPA

SPA Error

The error associated with the 2003 inseason SPA escapement estimates is considered a minimum estimate of the error, based on the relatively high accuracy of the 2003 SPA models and the fact that aging and sampling error were not included. The 90% confidence interval surrounding the Black Lake escapement estimate of 350,004 ranged from 284,903 to 418,317. The 90% confidence interval surrounding the Chignik Lake escapement estimate of 334,119 ranged from 265,806 to 399,220 (Figure 5).

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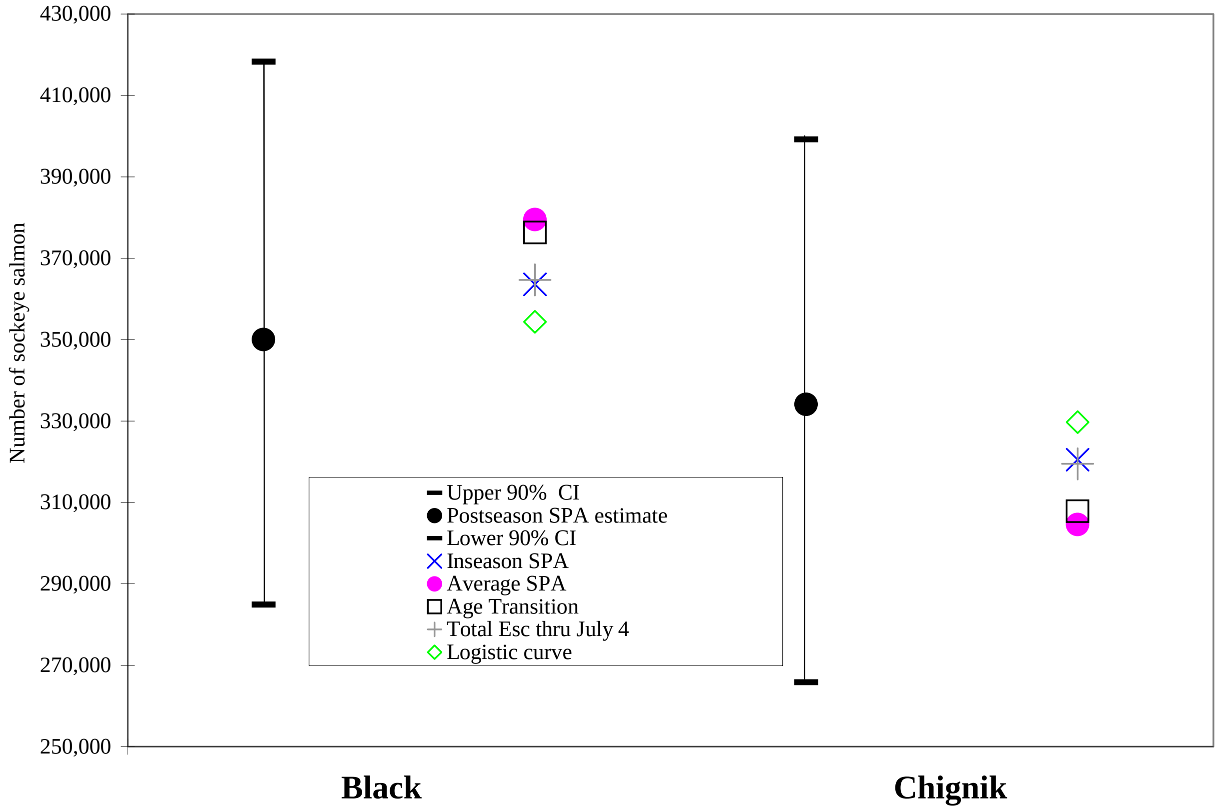

Figure 5. The 90% confidence intervals surrounding the postseason SPA estimates of escapement for Black Lake and Chignik Lake during 2003 compared to estimates for 2003 from potential alternative inseason methods of run separation and the inseason SPA previously utilized.

There was significant variability surrounding the postseason SPA escapement estimates. It is likely that other seasons' estimates had significantly larger ranges around them due to less accurate model performance in those years.

Inseason Estimates

Escapement estimates using each method were compared to the postseason SPA estimate because, by year, they were assumed to be the most accurate estimates currently available, with which to evaluate the results. Only the Black Lake escapements were used to evaluate the estimates because management actions were based on estimates of escapement to Black Lake during the first portion of the season. The results of any Black Lake estimate would be directly inverse to those of the Chignik Lake estimate and evaluating the Chignik Lake estimate separately would be redundant.

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Inseason SPA

The inseason SPA estimate had a moderate bias towards overestimating the Black Lake escapement, as measured by the average difference between the inseason SPA estimate and the postseason SPA estimate (Table 1). The inseason SPA estimates were among the most precise estimates as measured by the average squared difference.

Table 1. Results from the inseason SPA Black Lake escapement estimates compared to the postseason SPA and the average difference and average squared difference of the estimates.

Year	Postseason SPA	Inseason SPA	Inseason SPA Difference
1986	566,088		
1987	589,291		
1988	420,577	421,823	1,246
1989	384,004	417,437	33,433
1990	434,543	470,998	36,455
1991	657,511	722,138	64,627
1992	360,681	488,504	127,823
1993	364,261	398,582	34,321
1994	769,462	682,459	-87,003
1995	366,163	405,664	39,501
1996	464,749	419,185	-45,564
1997	396,667	438,491	41,824
1998	410,658	393,731	-16,927
1999	457,425	394,536	-62,889
2000	536,141	512,649	-23,492
2001	744,013	826,653	82,640
2002	380,701	383,360	2,659
2003	350,004	363,596	13,592
Average Difference			15,140
Average squared Difference			2.72E+09

Average SPA

The average SPA estimates were reasonably accurate with a slight bias to underestimate the Black Lake escapement when compared to postseason SPA estimates (Table 2). This tendency to underestimate however, was weighted significantly by a few years in which the average SPA method greatly underestimated the Black Lake escapement (e.g., 1987 and 1994). The average SPA method was reasonably precise.

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Table 2. Results from the average SPA Black Lake escapement estimates compared to the postseason SPA and the average difference and average squared difference of the estimates.

Year	Postseason SPA	Average SPA	Average SPA Difference
1986	566,088	474,699	-91,389
1987	589,291	472,386	-116,905
1988	420,577	440,380	19,803
1989	384,004	446,335	62,331
1990	434,543	458,543	24,000
1991	657,511	640,460	-17,051
1992	360,681	431,545	70,864
1993	364,261	426,598	62,337
1994	769,462	637,186	-132,276
1995	366,163	432,239	66,076
1996	464,749	423,474	-41,275
1997	396,667	425,380	28,713
1998	410,658	442,287	31,629
1999	457,425	412,901	-44,524
2000	536,141	472,911	-63,230
2001	744,013	758,015	14,002
2002	380,701	385,111	4,410
2003	350,004	379,511	29,507
Average Difference			-5,165
Average squared Difference			3.81E+09

Logistic Curves

The first of the two logistic models (referred to as the early curve) represents the majority of the years included in these analyses (Figure 6). The early curve has a gradual incline in the proportion of Chignik Lake fish composing the total daily escapement. On around July 6, about 50% of the total daily escapement passing the weir is attributable to Chignik Lake (the 50/50 date; Figure 1, Point A).

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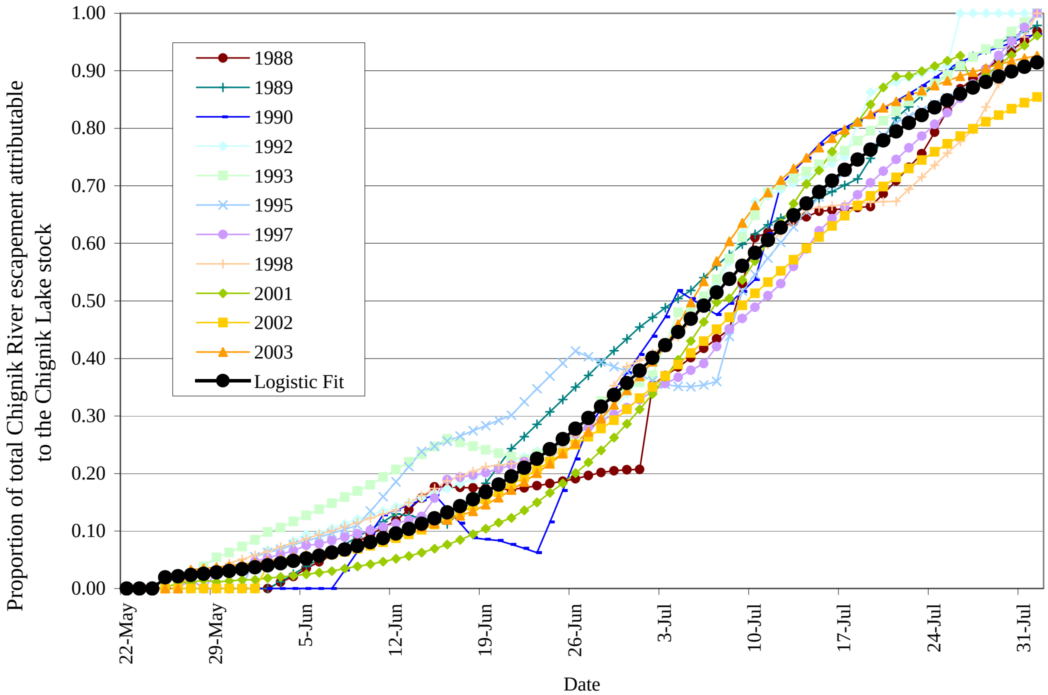

Figure 6. The daily proportion of the Chignik Lake stock estimated by postseason SPA and the "early" logistic fit proportional time of entry curve.

The second logistic model (referred to as the late curve) is represented by fewer years (Figure 7). It indicates a slower build-up of sockeye salmon bound for Chignik Lake. During these years Chignik Lake fish composed 50% of the daily escapement on around July 15.

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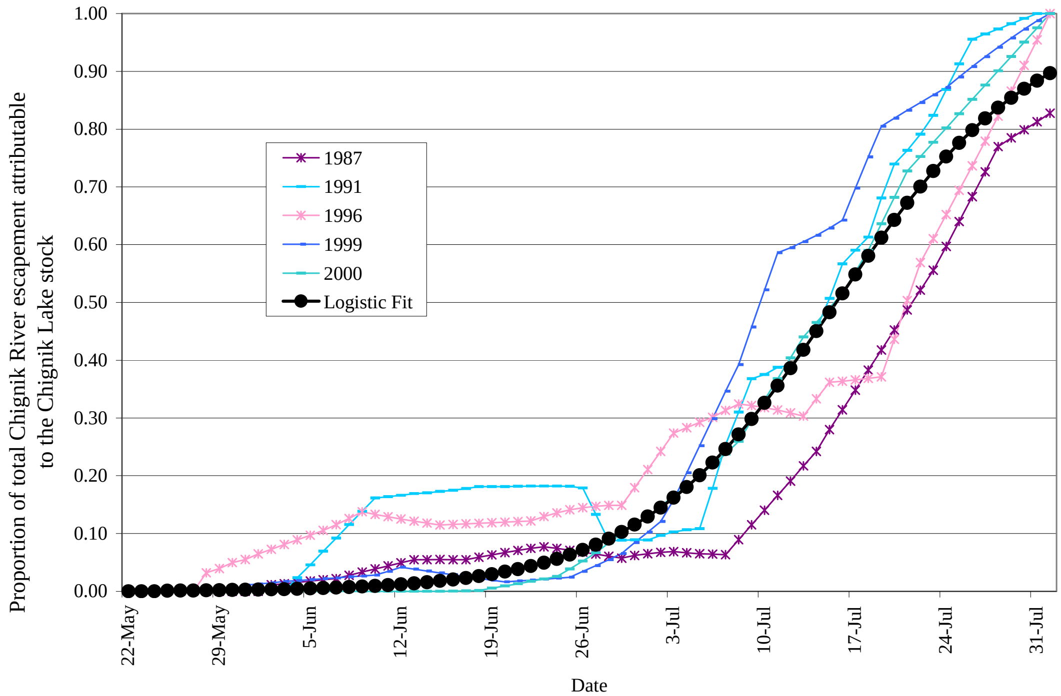

Figure 7. The daily proportion of the Chignik Lake stock estimated by postseason SPA and the "late" logistic fit proportional time of entry curve.

These two curves were used in combination across the years examined. The early curve was applied to years in which the run timing of Chignik Lake run was early and the late curve was applied in years that the Chignik Lake run was late. The combination of curves resulted in a relatively low accuracy with a tendency to overestimate the Black Lake escapement (Table 3). However, logistic curves method had the highest precision of all of the estimates based on the average squared difference.

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Table 3. Results from the logistic curves Black Lake escapement estimates compared to the postseason SPA and the average difference and average squared difference of the estimates.

Year	Postseason SPA	Logistic Curves	Logistic Curves Difference
1986	566,088		
1987	589,291	547,566	-41,725
1988	420,577	409,183	-11,394
1989	384,004	416,999	32,995
1990	434,543	424,868	-9,675
1991	657,511	743,339	85,828
1992	360,681	393,755	33,074
1993	364,261	407,558	43,297
1994	769,462		
1995	366,163	398,076	31,913
1996	464,749	487,287	22,538
1997	396,667	394,581	-2,086
1998	410,658	506,618	95,960
1999	457,425	480,051	22,626
2000	536,141	557,399	21,258
2001	744,013	705,249	-38,764
2002	380,701	356,987	-23,714
2003	350,004	354,389	4,385
Average Difference			16,657
Average squared Difference			1.51E+09

It is unclear what physical or biological parameters trigger the differences in run timing; however, there is a reasonable correlation between May air temperatures (as measured in Cold Bay Alaska) and the timing of the late Chignik Lake run. The later curve is also positively correlated with a later transition of dominance between the age 1.3 and age 2.3 sockeye salmon. A combination of these two characteristics may be used to determine which curve would be more appropriate prior to and during a given season.

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Age Transition

The estimate based on the age transition date tended, on average, to overestimate the Black Lake escapement when compared to postseason SPA estimates and was the least precise of all of the estimation methods (Table 4).

Table 4. Results from the age transition Black Lake escapement estimates compared to the postseason SPA and the average difference and average squared difference of the estimates.

Year	Postseason SPA	Age Transition	Age Transition Difference
1986	566,088	444,501	-121,587
1987	589,291	547,564	-41,727
1988	420,577	379,416	-41,161
1989	384,004	414,339	30,335
1990	434,543	404,630	-29,913
1991	657,511	712,626	55,115
1992	360,681	510,457	149,776
1993	364,261	370,109	5,848
1994	769,462	670,816	-98,646
1995	366,163	445,933	79,770
1996	464,749	432,333	-32,416
1997	396,667	467,591	70,924
1998	410,658	474,842	64,184
1999	457,425	434,956	-22,469
2000	536,141	570,093	33,952
2001	744,013	1,034,191	290,178
2002	380,701	392,378	11,677
2003	350,004	376,304	26,300
Average Difference			23,897
Average squared Difference			8.81E+09

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Total escapement though a fixed date

The unweighted average of the dates at which total escapement approximated the postseason Black Lake escapement estimate was July 4. The estimate was slightly biased to underestimate the Black Lake escapement, due in a large part to a few years that greatly underestimated the escapement (e.g., 1986, 1987, and 2000). The precision was lower than three of the other five methods (Table 5).

Table 5. Results from the total escapement through a fixed date Black Lake escapement estimates compared to the postseason SPA and the average difference and average squared difference the estimates.

Year	Postseason SPA	Escapement thru July 4	Escapement thru July 4 Difference
1986	566,088	444,501	-121,587
1987	589,291	441,911	-147,380
1988	420,577	451,611	31,034
1989	384,004	425,295	41,291
1990	434,543	406,820	-27,723
1991	657,511	678,305	20,794
1992	360,681	396,024	35,343
1993	364,261	403,982	39,721
1994	769,462	666,706	-102,756
1995	366,163	449,896	83,733
1996	464,749	420,488	-44,261
1997	396,667	420,252	23,585
1998	410,658	481,619	70,961
1999	457,425	420,170	-37,255
2000	536,141	407,941	-128,200
2001	744,013	850,348	106,335
2002	380,701	392,378	11,677
2003	350,004	364,665	14,661
Average Difference			-7,224
Average squared Difference			5.70E+09

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DISCUSSION

The estimates from each method evaluated in this analysis fell well within the confidence bounds of the 2003 postseason estimate (Figure 5) and would likely fall within these bounds in all years. Therefore, all of these estimation methods would be relatively accurate.

The inseason SPA estimation method, which the method selected from this review would replace, was among the more accurate and precise of the estimates (Tables 1 and 6). The advantage of the inseason SPA method was that it tended to respond more favorably to unusual run timing or significant differential magnitude between the runs. What the inseason SPA lacked in overall precision and accuracy, it made up for in responsiveness to interannual changes.

Table 6. A comparison using average difference and average squared difference of all of the inseason estimation methods of Black Lake escapement with the postseason SPA method.

	Inseason SPA	Average SPA	Logistic Curves	Age Transition	Escapement thru July 4
Average Difference	15,140	-5,165	16,657	23,897	-7,224
Average squared Difference	2.72E+09	3.81E+09	1.51E+09	8.81E+09	5.70E+09

The most significant problem with using the SPA model inseason was the management delay associated with the model development. Since the Chignik Lake run had to be present in a significant proportion to determine if the SPA model was working, there was no information about the proportion of the two runs in the escapement prior to the first week in July. The fishery was generally managed so that 400,000 fish escaped by June 30. Since the halfway point of the overlap period is usually after June 30 (calculated to be July 4 by this analysis), there were usually additional fish that were allocated to the early run at the time that the inseason SPA model was released. This typically resulted in escapements to Black Lake that exceeded the established goal. When the inseason SPA model was finally released, the late run was increasing in magnitude and the fishery was usually managed based on the Chignik Lake escapement. Since the inseason SPA model allocated many fish during June to the late run, the Chignik Lake escapement was often ahead of the interim escapement objectives. The fishery frequently had to be aggressively managed to get the escapement back on to the interim objective schedule.

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The age transition estimation method is founded on sound reasoning, but the interannual variability of age compositions of each run and the variable run timing between runs render this estimation method unreliable inseason (Table 4).

The logistic curves estimation method (Tables 3 and 6; Figures 5, 6, and 7) and the average SPA proportional time of entry curves (Tables 2 and 6; Figures 3 and 5) appear to provide the best estimate based on measures of precision, relative to the postseason SPA estimate. While the logistic curve distribution and the average SPA time of entry curves approximate the postseason estimate as far as the total escapement by run, the estimated timing that each stock enters the system is quite different from the run timing reflected in the current interim escapement objective schedule. For example, the last interim escapement objective for the early run occurs on June 30; however, applying the average SPA or logistic curves to the daily escapement would result in escapement attributed to the early run occurring throughout July. If the fishery were to be managed using either of these proportional time of entry curves, a new interim escapement objective schedule would have to be developed to reflect early-run escapement objectives through July and late-run escapement objective beginning in early June. This drastic change would be difficult for management staff to implement, and while it might work well in theory, the actual application of such a change could produce unforeseen results.

The ramifications of selecting the inappropriate logistic curve in a given year, despite the seemingly reliable indicators of temperature and age composition, could exacerbate the inaccuracy of the estimate compared to a more static apportionment method.

Since there was little success from this analysis in developing an accurate and precise new method that uses inseason data (e.g., age transition model, logistic curves), the remaining goal was to determine which estimation method would work well in the majority of situations.

The analysis of the date at which the total escapement most closely approximates the postseason apportionment of the Black Lake escapement indicated that July 4 is the most appropriate date on average. This estimate is calculated using an average of the best date during each year from 1986 through 2003 and is not a weighted estimate based upon size of annual escapements. Thus, years of large escapements do not overshadow years of small escapements in derivation of the appropriate date. Therefore, assuming that there are no major shifts in run timing, this date would continue to provide a reasonable estimation of the escapement to each run. So, one could expect the total escapement on July 4 in any given year to reasonably approximate the total Black Lake escapement.

Managing the fishery with a fixed date to differentiate the early run has many benefits. Management based on this strategy eliminates the management delay and period of uncertainty that was commonly encountered while the inseason SPA model was being developed. Since the fishery was actively managed to achieve the management objectives before the inseason SPA model was developed each year, the Black Lake escapement was usually achieved by June 30. This analysis has revealed that the more appropriate date to separate the runs is July 4, so in the

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past, additional fish were usually allowed to escape the commercial fishery, thereby exceeding the Black Lake escapement goal.

As estimated by postseason SPA, the Black Lake escapement has exceeded the upper end of the escapement goal in 11 of the last 15 years. By managing the Black Lake escapement through July 4, (rather than through June 30 prior to establishment of the inseason SPA model) it will be less likely that postseason calculations will estimate that additional fish escaped into Black Lake and escapement into Black Lake should be closer to the escapement goal and fish surplus to the goals can be commercially harvested.

It is difficult to estimate what the effects would have been in past years using the fixed-date management strategy. By examining total escapement through June 30, the benchmark by which the early-run fishery is managed before the inseason SPA is developed annually, the impacts of a fixed-date management strategy can be approximated. The additional escapement that occurred after June 30, through July 4 would be harvested under the fixed-date scenario (Table 7).

Table 7. Total escapement through June 30, July 4, and increased potential early-run commercial harvests resulting from a fixed escapement date management strategy.

	Total Escapement Through June 30	Total Escapement Through July 4	Additional Early-run Harvest Potential
1986	374,585	444,501	69,916
1987	433,397	441,911	8,514
1988	426,351	451,611	25,260
1989	405,652	425,295	19,643
1990	401,011	406,820	5,809
1991	612,098	678,305	66,207
1992	384,135	396,024	11,889
1993	388,986	403,982	14,996
1994	661,463	666,706	5,243
1995	378,954	449,896	70,942
1996	399,850	420,488	20,638
1997	391,952	420,252	28,300
1998	474,842	481,619	6,777
1999	397,217	420,170	22,953
2000	395,931	407,941	12,010
2001	717,534	850,348	132,814
2002	357,586	392,378	34,792
2003	353,265	364,665	11,400

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To investigate whether more or less fishing time would have been directed on the early or late run in each year under the new fixed-date fishing strategy, the cumulative escapement on specific dates in each year was examined. To evaluate if more fishing days would have been permitted on the early run, the total cumulative escapement on July 4 was examined (Table 8). If the escapement was above the upper end escapement goal (400,000), more fishing would likely have occurred. The exception would be for the 2003 season during which the department targeted 350,000 fish and any fish in excess to 350,000 that had escaped by June 30 would indicate potential additional fishing time. During 1986 through 2003, more fishing time would have been allowed directed on the early run in 16 of the 18 years.

Table 8. Actual total cumulative escapements on July 4 and July 5 through July 10 during 1986 through 2003.

	Total Escapement Through July 4	Escapement from July 5 through July 10
1986	444,501	119,331
1987	441,911	92,759
1988	451,611	25,585
1989	425,295	38,419
1990	406,820	93,383
1991	678,305	27,565
1992	396,024	16,854
1993	403,982	88,230
1994	666,706	15,492
1995	449,896	9,455
1996	420,488	24,237
1997	420,252	28,153
1998	481,619	6,379
1999	420,170	14,786
2000	407,941	56,358
2001	850,348	13,357
2002	392,378	21,059
2003	364,665	40,954

A similar investigation of the late run was also undertaken. The total escapement from July 5 through July 10, which would be the first interim escapement objective for the late run, was

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examined (Table 8). If the escapement during this time period was less than the July 10 sockeye salmon interim objective of 40,000 fish, less fishing time would have been permitted. During the 18 year period (1986 through 2003) less fishing time during that period would have occurred in 12 of the last 18 seasons.

Under the new scenario, the management strategy would shift to target the late-run escapement objectives beginning on July 5. The magnitude of the late-run interim escapement objective schedule would remain unchanged; however, additional interim goals would be developed. The net result of the change in management would be decreased escapement (and increased harvest) during the later portion of June and early July when there are likely to be more early-run fish in the fishery, and increased escapement (and decreased harvest) during early July (July 5 to 10) when there is likely a larger proportion of late-run fish in the fishery.

The result of this strategy is essentially a modification of the time period during which fish are harvested. Since the same early-run and late-run goals are targeted, the total escapement goals to both runs remain unchanged and as a result, the total harvest remains unchanged under perfectly precise management (management in which escapement objectives are exactly achieved). In reality however, since overescapement has often occurred due to inseason versus postseason apportionments, inseason modeling and management delays, less efficient fishing openings, weather, et cetera, the fixed-date management strategy will likely result in overall additional harvest as a direct result of decreased overescapement.

RECOMMENDATIONS

Based on this analysis and due to the loss of the inseason run apportionment project, the best strategy is to establish a fixed date up to which all fish are considered Black Lake escapement and after which all fish are considered Chignik Lake escapement. This will facilitate management of the fishery, and minimize the impacts of the potential problems associated with a method based on environmental variables (e.g., Cold Bay air temperature). Statistically, this method, as well as all of the other methods, fall well within the confidence bounds of our best estimate for 2003 and likely would in all years.

This management change should reduce the chronic overescapement of the Black Lake stock, which is often due, in part, to differences between inseason and postseason run apportionment. Additionally, increased escapement during early July (July 5 through 10) should allow additional Chignik Lake fish to escape early in the run during the time that the strength of entire Chignik Lake run cannot be measured.

While this method is not likely as accurate as inseason SPA, nor will it be reactive to year to year changes, we believe that July 4 represents the best date to use to separate the Black Lake and Chignik Lake escapements and recommend that the fishery be managed as such during the 2004 season. The postseason method of separating the runs without SPA has not yet been established; however, the selection of this date will be further evaluated postseason, when the postseason run separation is performed.

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